K S INSTITUTE OF TECHNOLOGY

#14, Raghuvanahalli, Kanakapura Main Road, Bengaluru-560109

Department Of Artificial Intelligence & Machine Learning

LABORATORY MANUAL

"DATA STRUCTURES LABORATORY"

Subcode: BCSL305

Prepared By

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[illegible] 12/12/2023

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Document Log

Name of the document	DATA STRUCTURES LABORATORY
Syllabus Scheme	2022
Subject code	BCSL305
Editorial Committee	Dr. Vijayalaxmi Mekali, Prof. Usha C R Mrs. Renuka Patil
Approved by	HOD, Dept. of AIML
Lab faculty	Dr. Vijayalaxmi Mekali, Prof. Usha C R Mrs. Renuka Patil
Computer Programmer	Mr. Ganesh M L

K. S. INSTITUTE OF TECHNOLOGY

Department of Artificial Intelligence and Machine Learning

Vision of the Institute

To impart quality technical education with ethical values, employable skills and research to achieve excellence.

Mission of the Institute

- To attract and retain highly qualified, experienced and committed faculty.
- To create relevant infrastructure
- Network with industry and premier institutions to encourage emergence of new ideas by providing research and development facilities to strive for academic excellence
- To inculcate the professional and ethical values among young students with employable skills and knowledge acquired to transform the society

Vision of the Department

To harness students' creativity and self-belief to be successful global professionals with human touch

Mission of the Department

- Use experiential learning approach to empower students with fundamentals of theory and practice.
- Enable students to solve real life problems both at national and international level.
- To promote entrepreneurship among students so as to be job creators.

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K. S. INSTITUTE OF TECHNOLOGY

Department of Artificial Intelligence and Machine Learning

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Empower students to solve real life problems by utilizing state of the art technologies.

PEO2: Promote entrepreneurship among students, emphasizing on innovation by redefining the way of doing things, to facilitate better living in societies.

PEO3: Unleash and nurture the creativity of students for implementation of improved ideas, knowledge and practices

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Ability to apply the fundamental concepts of Artificial Intelligence and Machine Learning to design and develop solutions to multidisciplinary problems of social concern.

PSO2: Ability to use the inculcated experiential learning for research and development activities in compliance with National Education Policy.

PROGRAM OUTCOMES (POs)

PO1: Engg Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and engg. specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

PO3: Design/Development: Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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PO4: Conduct Investigations: Use research-based knowledge 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: Engineer and Society: 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.

PO7: Environment: 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 team work: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

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

PO12: Lifelong 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.

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#14, Raghuvanahalli, Kanakapura Main Road, Bengaluru-5600109

DEPARTMENT OF ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

Course: Data Structures Laboratory		
Type: Core	Course Code:BCSL305	Academic year:2023-2024
Faculty Name: Dr. Vijayalaxmi Mekali Mrs. Usha C R, Mrs. Renuka Patil	Sem: III	Sec:A

No of Hours per week		
Number of Lecture Hours/Week	Total/Week	Total teaching hours
02P	3hrs	28

Marks			
Internal Assessment	Examination	Total	Credits
50	50	100	1

Aim/Objective of the Course:

To study the different types of data structures, operations on data structures and their applications

Course Learning Outcomes:
After completing the course, the students will be able to, Bloom's Level

BCSL305.1	**Select** implementation procedures to demonstrate the various operations on different data structures.	Applying (K3)
BCSL305.2	**Develop** the C programs to implement various operations on different data structures.	Applying (K3)
BCSL305.3	**Identity** suitable data structures to implement stack, queues, trees, graphs and hash table.	Applying (K3)
BCSL305.4	**Experiment with** C programs to implement stack, queues, trees, graph and hash table with different data structures.	Applying (K3)
BCSL305.5	**Apply** concepts of arrays, stack, queue, linked list, trees and graph to solve different problems.	Applying (K3)

Syllabus Content	
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.	CO1,CO2 CO3,CO4 CO5 PO1-3, PO2-2 PO3-2, PO5-1 PSO1-2, PSO2-2

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.	CO1,CO2 CO3,CO4 CO5 PO1-3, PO2-2 PO3-2, PO5-1 PSO1-2, PSO2-2
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	CO1,CO2 CO3,CO4 CO5 PO1-3, PO2-2 PO3-2, PO5-1 PSO1-2, PSO2-2
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.	CO1,CO2 CO3,CO4 CO5 PO1-3, PO2-2 PO3-2, PO5-1 PSO1-2, PSO2-2
5. Develop 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	CO1,CO2 CO3,CO4 CO5 PO1-3, PO2-2 PO3-2, PO5-1 PSO1-2, PSO2-2
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	CO1,CO2 CO3,CO4 CO5 PO1-3, PO2-2 PO3-2, PO5-1 PSO1-2, PSO2-2
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	CO1,CO2 CO3,CO4 CO5 PO1-3, PO2-2 PO3-2, PO5-1 PSO1-2, PSO2-2

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	CO1,CO2 CO3,CO4 CO5 PO1-3, PO2-2 PO3-2, PO5-1 PSO1-2, PSO2-2
9. Develop a Program in C for the following operationson 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	CO1,CO2 CO3,CO4 CO5 PO1-3, PO2-2 PO3-2, PO5-1 PSO1-2, PSO2-2
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	CO1,CO2 CO3,CO4 CO5 PO1-3, PO2-2 PO3-2, PO5-1 PSO1-2, PSO2-2
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	CO1,CO2 CO3,CO4 CO5 PO1-3, PO2-2 PO3-2, PO5-1 PSO1-2, PSO2-2
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 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.	CO1,CO2 CO3,CO4 CO5 PO1-3, PO2-2 PO3-2, PO5-1 PSO1-2, PSO2-2

Assessment: Experiment distribution

o For laboratories having only one part: Students are allowed to pick one experiment from the lot with equal opportunity.

o For laboratories having PART A and PART B: Students are allowed to pick one experiment from PART A and one experiment from PART B, with equal opportunity.

• Change of experiment is allowed only once and marks allotted for procedure to be made zero of the changed part only.

• Marks Distribution (Need to change in accordance with university regulations)

c) For laboratories having only one part – Procedure + Execution + Viva-Voce: 15+70+15 = 100 Marks

d) For laboratories having PART A and PART B

i. Part A – Procedure + Execution + Viva = 6 + 28 + 6 = 40 Marks

ii. Part B – Procedure + Execution + Viva = 9 + 42 + 9 = 60 Marks

CO to PO Mapping

PO1: Science and engineering Knowledge **PO2:** Problem Analysis **PO3:** Design & Development **PO4:**Investigations of Complex Problems **PO5:** Modern Tool Usage **PO6:** Engineer & Society	**PO7:**Environment and Society **PO8:**Ethics **PO9:**Individual & Team Work **PO10:** Communication **PO11:**Project Management & Finance **PO12:**Life long Learning

PSO1: Ability to apply the fundamental concepts of Artificial Intelligence and Machine Learning to design and develop solutions to multidisciplinary problems of social concern.

PSO2: Ability to use the inculcated experiential learning for research and development activities in compliance with National Education Policy.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
BCSL305.1	3	2	2		1							
BCSL305.2	3	2	2		1							
BCSL305.3	3	2	2		1							
BCSL305.4	3	2	2		1							
BCSL305.5	3	2	2		1							
BCSL305	**3**	**2**	**2**		**1**							

CO	PSO1	PSO2
BCSL305.1	2	2
BCSL305.2	2	2
BCSL305.3	2	2
BCSL305.4	2	2
BCSL305.5	2	2
BCSL305	2	2

3	Substantial (High) Correlation
2	Moderate (Medium) Correlation
1	Slight (Low) Correlation
-	No correlation.

[illegible] [illegible] [illegible]

Signature of Course In-Charge **Signature of Module Coordinator** **Signature of HOD**

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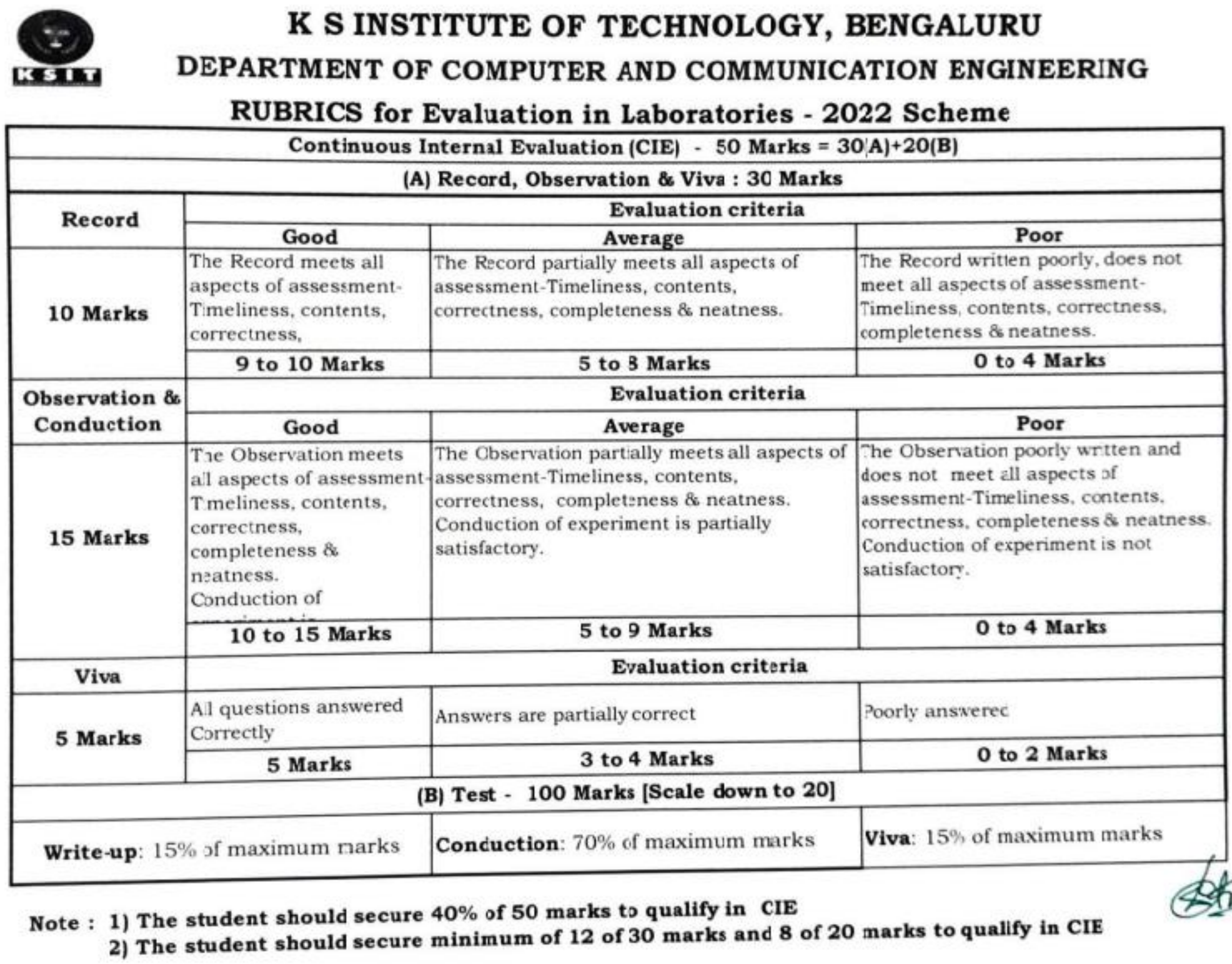

K S INSTITUTE OF TECHNOLOGY, BENGALURU

DEPARTMENT OF COMPUTER AND COMMUNICATION ENGINEERING

RUBRICS for Evaluation in Laboratories - 2022 Scheme

Continuous Internal Evaluation (CIE) - 50 Marks = 30(A)+20(B)

(A) Record, Observation & Viva : 30 Marks

Record	**Evaluation criteria**		
	Good	**Average**	**Poor**
10 Marks	The Record meets all aspects of assessment-Timeliness, contents, correctness,	The Record partially meets all aspects of assessment-Timeliness, contents, correctness, completeness & neatness.	The Record written poorly, does not meet all aspects of assessment-Timeliness, contents, correctness, completeness & neatness.
	9 to 10 Marks	**5 to 8 Marks**	**0 to 4 Marks**
Observation & Conduction	**Evaluation criteria**		
	Good	**Average**	**Poor**
15 Marks	The Observation meets all aspects of assessment-Timeliness, contents, correctness, completeness & neatness. Conduction of	The Observation partially meets all aspects of assessment-Timeliness, contents, correctness, completeness & neatness. Conduction of experiment is partially satisfactory.	The Observation poorly written and does not meet all aspects of assessment-Timeliness, contents, correctness, completeness & neatness. Conduction of experiment is not satisfactory.
	10 to 15 Marks	**5 to 9 Marks**	**0 to 4 Marks**
Viva	**Evaluation criteria**		
5 Marks	All questions answered Correctly	Answers are partially correct	Poorly answered
	5 Marks	**3 to 4 Marks**	**0 to 2 Marks**

(B) Test - 100 Marks [Scale down to 20]

Write-up: 15% of maximum marks	**Conduction**: 70% of maximum marks	**Viva**: 15% of maximum marks

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Note : 1) The student should secure 40% of 50 marks to qualify in CIE
2) The student should secure minimum of 12 of 30 marks and 8 of 20 marks to qualify in CIE

Programs List:	
1.	Develop a Program in C for the following: a) Declare a calendar as an array of 7 elements (A dynamically Created array) to represen days of a week. Each Element of the array is a structure having three fields. The first fie is the name of the Day (A dynamically allocated String), The second field is the date the Day (A integer), the third field is the description of the activity for a particular day 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.
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Laboratory Outcomes: The student should be able to:

- **Analyze various linear and non-linear data structures**
- **Demonstrate the working nature of different types of data structures and their applications**
- **Use appropriate searching and sorting algorithms for the give scenario.**
- **Apply the appropriate data structure for solving real world problems**

Conduct of Practical Examination:

- Experiment distribution
  - o For laboratories having only one part: Students are allowed to pick one experiment from the lot with equal opportunity.
  - o For laboratories having PART A and PART B: Students are allowed to pick one experiment from PART A and one experiment from PART B, with equal opportunity.
- Change of experiment is allowed only once and marks allotted for procedure to be made zero of the changed part only.
- Marks Distribution (Need to change in accordance with university regulations)
  - c) For laboratories having only one part – Procedure + Execution + Viva-Voce: 15+70+15 = 100 Marks
  - d) For laboratories having PART A and PART B
    - i. Part A – Procedure + Execution + Viva = 6 + 28 + 6 = 40 Marks
    - ii. Part B – Procedure + Execution + Viva = 9 + 42 + 9 = 60 Marks

LAB EXPERIMENTS

PROGRAM 1.

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>
struct date
{
   int day;
   int month;
   int year;
};
struct calender
{
    char week[12];
    struct date d;
    char activity[20];
};
typedef struct calender* cal;
cal mycal;
void main()
 {
          create();
          read();
          display();
 } /*end of main*/
```

```
void create()
{
   mycal=(cal)malloc(sizeof(struct calender)*7);
 }/*end of create*/
void read()
{
            int i;
            for(i=1;i<=7;i++)
            {
                      printf("Enter the week activity details::day %d",i);
                      printf("\nEnter day name::");
                      scanf("%s",mycal[i].week);
                      printf("\nEnter day date::");
                      scanf("%d%d%d",&mycal[i].d.day,&mycal[i].d.month,&mycal[i].d.year);
                      printf("\nEnter day activity::");
                      scanf("%s",mycal[i].activity);
             } /*end of for*/
 } /*end of read*/
 void display()
 {
            int i;
            for(i=1;i<=7;i++)
           {
                      printf("\nWeek activity details::day %d\n",i);
                      printf("\nDay name:%s\t",mycal[i].week);
                      printf("\n Day date:%d/%d/%d\t",mycal[i].d.day,mycal[i].d.month,mycal[i].d.year);
                      printf("\n Day activity:%s\n",mycal[i].activity);
            } /*end of for*/
 } /*end of display*/
```

Output

```
Enter the week activity details::day 1
Enter day name::Monday

Enter day date::1 12 2023

Enter day activity::Yoga
Enter the week activity details::day 2
Enter day name::Tuesday

Enter day date::2 12 2023

Enter day activity::Sports
Enter the week activity details::day 3
Enter day name::Wednesday

Enter day date::3 12 2023

Enter day activity::cultural
Enter the week activity details::day 4
Enter day name::Thursday

Enter day date::4 12 2023

Enter day activity::Seminar
Enter the week activity details::day 5
Enter day name::Friday

Enter day date::5 12 2023

Enter day activity::groupdiscussion
Enter the week activity details::day 6
Enter day name::Saturday

Enter day date::6 12 2023

Enter day activity::musical
Enter the week activity details::day 7
Enter day name::Sunday
Enter day date::7 12 2023

Enter day activity::Holiday

Week activity details::day 1

Day name:Monday Day date:1/12/2023      Day activity:Yoga

Week activity details::day 2

Day name:Tuesday        Day date:2/12/2023      Day activity:Sports

Week activity details::day 3

Day name:Wednesday      Day date:3/12/2023      Day activity:cultural

Week activity details::day 4

Day name:Thursday       Day date:4/12/2023      Day activity:Seminar

Week activity details::day 5

Day name:Friday Day date:5/12/2023      Day activity:groupdiscussion

Week activity details::day 6

Day name:Saturday       Day date:6/12/2023      Day activity:musical

Week activity details::day 7
```

PROGRAM 2.

2. Develop a program in C for the following operations on String

a. Read a Main String (STR), a Pattern String (PAT) & Replace String (REP)
b. Perform Pattern Matching Operations. Find & 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>
void read(char str[],char pat[],char rep_pat[]);
void replace(char str[],char pat[],char rep_pat[],char new_str[]);
int main()
{
        char str[100],pat[20],rep_pat[20],new_str[100];
        read(str,pat,rep_pat);
        replace(str,pat,rep_pat,new_str);
} /*end of main*/
void read(char str[],char pat[],char rep_pat[])
{
        printf("Enter the String\n");
        scanf("%s",str);
        printf("Enter the pattern to be searched\n");
        scanf("%s",pat);
        printf("Enter the replacing String with %s\n",pat);
        scanf("%s",rep_pat);
}/*end of read*/
void replace(char str[],char pat[],char rep_pat[],char new_str[])
{
        int i=0,j=0,k,rep_ind,flag=0, mflag=0,n=0;
        while(str[i]!='\0')
        {
                j=0,k=i,rep_ind=0;
                while((str[k]==pat[j])&&(pat[j]!='\0'))
                {
                        k++;
                j++;
            } /*end of inner while*/
            if (pat[j]=='\0')
            {
                flag=1;
                mflag=1;
                while(rep_pat[rep_ind]!='\0')
                {
                    new_str[n++]=rep_pat[rep_ind++];
                } /*end of while*/
            } /*end of if*/
            else
            {
                flag=0;
            }/*end of else*/

            if(flag==1)
            {
                i=k;
            } /*end of if*/
            else
            {
                new_str[n++]=str[i++];
             } /*end of else*/
        } /*end of outer while*/
        if(mflag!=1)
        {
            printf("Pattern Not found\n");
            exit(0);
        } /*end of if*/
        new_str[n]='\0';
        printf("The new string is:\n");
        printf("%s\n",new_str);
}/*end of replace*/
```

OUTPUT1

```
Enter the String
KSIT
Enter the pattern to be searched
IT
Enter the replacing String with IT
TECH
The new string is:
KSTECH
OUTPUT2
Enter the String
KSITKSSEM
Enter the pattern to be searched
KS
Enter the replacing String with KS
KAMMAVARI
The new string is:
KAMMAVARIITKAMMAVARISEM
OUTPUT3

Enter the String
KSIT
Enter the pattern to be searched
IIT
Enter the replacing String with IIT
TECH
Pattern Not found
```

PROGRAM 3.

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<string.h>
#define max 5
void push(),pop(),display(),overflow_underflow(),palindrome();
int stack[max],top=-1,top1=-1;
void main()
{
    int ch ;
    printf("\nStack Operations\n");
    for(;;)
    {
            printf("\n1.Push\n 2.Pop\n 3.Character Stack to check palindrome\n
                  4.Overflow_Underflow\n 5.Display\n  6:Exit\n"); /*Note: type in single line*/
            printf("\nEnter your Choice:");
            scanf("%d",&ch);
            switch(ch)
            {
                    case 1: push();
                             break;
                    case 2: pop();
                            break;
                    case 3: palindrome();
                             break;
                    case 4: overflow_underflow();
                             break;
                    case 5: display();
                             break;
                    case 6: exit(0);
             }/*end of switch*/
    }/*end of for*/
} /* end of main*/
```

```
void push()
{
    int ele;
    if(top==max-1)
            printf("\nstack overflow\n");
     else
     {
         printf("\nEnter element to push:");
         scanf("%d",&ele);
         stack[++top]=ele;
      }/*end of else*/
} /*end of push function*/
void pop()
{
        int num;
        if(top==-1)
            printf("\nUnderflow\n");
        else
        {
                num=stack[top--];
                printf("\nPoped element::%d\n",num);
        } /*end of  else*/
}/* end of pop function*/

void overflow_underflow()
{
        if(top==max-1)
            printf("\nStack full\n");
        if(top==-1)
            printf("\nStack underflow\n");
} /*end of overflow_underflow*/
```

```
void display()
{
  int i;
  if(top==-1)
          printf("\nStack is Empty\n");
  else
 {
       printf("\n   Elements   on   stack   are::\n");
       for(i=top;i>=0;i--)
              printf("%d\n",stack[i]);
 } /*end of else*/
} /*end of display function*/
void palindrome()
{
    int i=0,j=0;
    char s[10],st[10],rev[10];
    printf("\nEnter the string to check palindrome::");
    scanf("%s",s);
    while(s[i]!='\0')
    {
         st[++top1]=s[i];
         i++;
    }/* end of while*/
    while(top1!=-1)
    {
       rev[j]=st[top1--];
       j++;
     }/* end of while*/
     rev[j]='\0';
     if(strcmp(s,rev)==0)
           printf("\nString %s is palindrome\n",s);
    else
          printf("\nString %s is not palindrome\n",s);
 }/* end of palindrome function*/
```

OUTPUT

```
Stack Operations

1.Push
 2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
6:Exit

Enter your Choice:1
Enter element to push:10
1.Push
2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
6:Exit
Enter your Choice:1
Enter element to push:20
1.Push
2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
 6:Exit

Enter your Choice:1
Enter element to push: 30
1.Push
2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
6:Exit

Enter your Choice:1
Enter element to push:40
1.Push
2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
6:Exit

Enter your Choice:1
Enter element to push:50
1.Push
 2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
 6:Exit

Enter your Choice:1
stack overflow

1.Push
2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
6:Exit
Enter your Choice:5
Elements on stack are::
50
40
30
20
10

1.Push
2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
```

```
5.Display
 6:Exit

Enter your Choice:2
Poped element::50
1.Push
2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
 6:Exit

Enter your Choice:2
Poped element::40
1.Push
2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
6:Exit

Enter your Choice:5

 Elements on stack are:: 30
20

1.Push
2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
6:Exit

Enter your Choice:3

Enter the string to check palindrom::bharath
String bharath is not palindrom
1.Push
```

```
 2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
6:Exit

Enter your Choice:3

Enter the string to check palindrome::dad
String dad is palindrome
1.Push
 2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
 6:Exit


10

Enter your Choice:2
Poped element::30
1.Push
2.Pop
3.Character Stack to check palindrome
4.Overflow_Underflow
5.Display
6:Exit

Enter your Choice:2

Poped element::20
 1.Push
2. Pop
3. Character Stack to check palindrome
4.Overflow_Underflow
5.Display
```

```
6:Exit

Enter your Choice:2
Poped element::10
1.Push
2. Pop
3. Character Stack to check palindrome
4.Overflow_Underflow
5.Display
6:Exit
Enter your Choice:4
Stack underflow
1.Push
2. Pop
3. Character Stack to check palindrome
4.Overflow_Underflow
5.Display
 6:Exit
```

PROGRAM 4:

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.

```
#include<stdio.h>
typedef enum{lparen,rparen,plus,minus,mul,div,mod,pow,eos,op} pred;
```

/* enum data pred gives value to (,), +,-,*, /, %,^ lparen is 0, rparen is 1, plus is 2 Minus is 3, mul is 4, div is 5, mod is 6, pow is 7, eos is 8, op(operand) is 9 program uses these value ex: in place of lparen it uses 0, ex: in place of plus it uses 2 so on isp stands for In Stack Priority and icp stands for In Coming Priority*/

```
int isp[ ]={0,19,12,12,13,13,13,14,0}; /* priority of operator when it is in stack*/
int icp[ ]={20,19,12,12,13,13,13,15,0}; /* priority of operator when it is out of stack*/
char exp[50],symbol; /* infix expression*/
pred stack[50]; /* stack contains only value of type enum pred*/
int top=0,n=0;
pred readtoken() /* to read character from infix expression*/
{
    symbol=exp[n++];
    switch(symbol)
    {
        case '(': return lparen;
        case ')': return rparen;
        case '+': return plus;
        case '-': return minus;
        case '*':return mul;
        case '/':return div;
        case '%':return mod;
        case '^':return pow;
        case '\0':return eos;
        default: return op;
    }/*end of switch*/
}/*end of readtoken()*/
```

```
void displaytoken(pred token)
{
    switch(token)
    {
        case plus:printf("+");
                  break;
        case minus:printf("-");
                   break;
        case mul:printf("*");
                 break;
        case div:printf("/");
                 break;
        case mod:printf("%%");
                 break;
        case pow:printf("^");
                 break;
    }/*end of switch*/
}/*end of displaytoken()*/
void push(pred item)
{
        stack[++top]=item;
 } /*end of push*/
pred pop()
{
        return stack[top--];
}/*end of pop*/
void infixtopost()
{
        pred token,token1;
        stack[0]=eos;
        token=readtoken();
        while(token!=eos) /* while loop to read the token*/
         {
                if(token==op) /* if character is operand copy to postfix*/
                {
                        printf("%c",symbol);
                }/*end of if*/
                else if(token==rparen) /*if character is right parenthesis pop stack until left
                                                paranenthes is on stack*/
                {
                        while(stack[top]!=lparen)
                        {
                           token1=pop();
                           displaytoken(token1);
                        }/*end of inner while*/
                         pop(); /*pop left paranenthesis from stack and ignore it*/
                }/*end of elseif*/
                else
                {
                        while(isp[stack[top]]>=icp[token]) /*if priority of operator on stack is > =priority
                        {                                     of incoming operator pop stack until operator
                                token1=pop();                      with less priority comes on stack */
                                displaytoken(token1);
                         }/*end of inner while & copy poped character to postfix ie display*/
                         push(token);    /* push incoming character to stack*/
                }/*end of else*/
            token=readtoken();
        }/*end of outer while loop to read the token*/
        while((token=pop())!=eos)    /*once end of infix expression if any operators remains on stack,
        {                                      pop all operators copy to postfix i.e display */
           displaytoken(token);
        }
        printf("\n");
}/* end of infixtopost() */

void  main()
{
           printf("PROGRAM TO CONVER INFIX EXP TO POSTFIX EXP\n\n");
           printf("Enter infix expression:");
           gets(exp);
           printf("Postfix expression:");
           infixtopost();
}
```

OUTPUT

```
PROGRAM TO CONVER INFIX EXP TO POSTFIX EXP

Enter infix expression:a^(b+c%d)+e
Postfix expression:abcd%+^e+

PROGRAM TO CONVER INFIX EXP TO POSTFIX EXP

Enter infix expression:a+(b*c-(d/e)+f)
Postfix expression:abc*de/-f++
```

PROGRAM 5.

5. Develop 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

```
#include<stdio.h>
#include<string.h>
#include<ctype.h>
#include<math.h>
#include<stdlib.h>
#define STACK_SIZE 50
/* isalnum() function checks whether a character is an alphanumeric character(a-z or A-Z,0-9)*/
/* isdigit() function checks whether character is numeric character(0-9) or not*/
/* atoi() converts string to integer*/

int stack[STACK_SIZE];
int top = -1;
void push(int a)
{
        stack[++top] = a;
        return;
}/*end of push*/
int pop()
{
        return (stack[top--]);
} /*end of pop*/
```

```
int eval(char s[])
{
        int i;
        int temp, op1, op2, result;
        char symbol[1];
        for(i = 0; i < strlen(s); i++)
        {
              if(isalnum(s[i]))
              {
                    if(isdigit(s[i]))
                    {
                          symbol[0] = s[i];
                          temp = atoi(symbol);
                          push(temp);
                    }/*end of inner if*/
                    else
                    {
                        printf("\n\nEnter a value of %c::",s[i]);
                        scanf("%d", &temp);
                        push(temp);
                    }/*end of else of inner if*/
              } /* end of outer if */
              else
              {
                    op2=pop();
                    op1=pop();
                    switch(s[i])
                    {
                         case '^': result = pow(op1, op2);
                               break;
                         case '*': result = op1 * op2;
                               break;
                         case '/': if(op2==0)
                                {
                                      printf("Divide by zero error\n\n");
                                      exit(0);
                                } /*end of if*/
                                else
                                       result = op1 / op2;
                                break;
                    case '%': if(op2==0)
                                 {
                                    printf("Divide by zero error\n\n");
                                    exit(0);
                                 }/*end of if*/
                                else
                                    result = op1 %op2;
                               break;
                    case '+': result = op1 + op2;
                               break;
                    case '-': result = op1 - op2;
                              break;
                    default: printf("Invalid Expression\n");
                               exit(0);
                }/*end of switch*/
                push(result);
            }/*end of else*/
    } /*end of for*/
    result = pop();
    if(top != -1)
    {
        printf("Invalid Expression\n");
        exit(0);
    } /*end of  if*/
    return result;
} /*end of eval function */
void main()
{
    char s[50];
    printf("\t\tEVALUATION OF POSTFIX EXPRESSION\n");
    printf("\n\nEnter the postfix expression\n");
    gets(s);
    printf("\n\nThe result of the evaluation is: d\n", eval(s));
    return;
}/*end of main function */
```

Note: To Compile the 5.a program use command (gcc filename.c –lm)

OUTPUT

```
EVALUATION OF POSTFIX EXPRESSION
Enter the postfix expression
ab*cd/+
Enter a value of a::2
Enter a value of b::3
Enter a value of c::8
Enter a value of d::4
The result of the evaluation is: 8
EVALUATION OF POSTFIX EXPRESSION
Enter the postfix expression
ab%cd^+e+

Enter a value of a::9

Enter a value of b::4
Enter a value of c::2

Enter a value of d::3
Enter a value of e::9
The result of the evaluation is: 18


EVALUATION OF POSTFIX EXPRESSION

Enter the postfix expression
93%24^+
The result of the evaluation is: 16
```

5b. Solving Tower of Hanoi problem with n disks

```
#include<stdio.h>
int tower(int n,char s, char t, char d)
{
             if(n==0)
                   return 0;
            tower(n-1,s,d,t);
            printf("\n Move disk %d from %c to %c\n",n,s,d);
            tower(n-1,t,s,d);
            return 0;
}
void main()
{
             char A,B,C;
             int n;
             printf("Enter the number of elements\n\n");
             scanf("%d",&n);
             printf("\n Sequence of disk\n");
             tower(n,'A','B','C');
             printf("\n");
}
```

OUTPUT:

```
1.Enter the number of disks:3

Sequence of disk
 Move disk 1 from A to C
 Move disk 2 from A to B
Move disk 1 from C to B
Move disk 3  from A to C

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

PROGRAM 6.

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 operations6.

```
#include <stdio.h>
#include<stdlib.h>
#include<stdio_ext.h>
#define max 5
int front=0,rear=-1,count=0;
char circularq[max];
void insert(),delete(),display();
void main()
{
        int choice;
        for(;;)
        {
                printf(" \n IMPLEMENTATION OF CIRCULAR QUEUE\n");
                printf("\n MENU\n");
                printf("\n1.INSERT\n 2.DELETE\n 3.DISPLAY\n 4.EXIT\n\n");
                printf("\nEnter Your Choice::");
                scanf("%d",&choice);
                switch(choice)
                {
                        case 1: insert();
                                break;
                        case 2: delete();
                                break;
                        case 3: display();
                                break;
                        default: exit(0);
                } /*end of switch*/
        } /*end of for*/
  } /*end of main*/
```

```
void insert()
{
      char item;
      if(count==max)
          printf("\nCIRCULAR QUEUE IS FULL\n");
     else
     {
          printf("\nEnter the item to be inserted::");
          fpurge(stdin);
          scanf("%c",&item);
          rear=(rear+1)%max;
          circularq[rear]=item;
          count++;
     } /*end of else*/
}/*end of insert function*/
void delete()
{
     char ch;
     if(count==0)
              printf("\nCIRCULAR QUEUE IS EMPTY\n");
     else
     {
          ch=circularq[front];
          printf("\nThe deleted element is::");
          printf("%c",ch);
          front=(front+1)%max;
          count--;
     } /*end of else*/
} /*end of delete function*/
```

```
void display()
{
        int i,j;
        char item;
        if(count==0)
                printf("CIRCULAR QUEUE IS EMPTY\n");
        else
        {
                printf("\nContents of the circular queue are:\n");
                j=front;
                for(i=1;i<=count;i++)
                {
                    item=circularq[j];
                   printf("%c",item);
                   j=(j+1)%max;
                   printf("\t");
                } /*end of for*/
        } /*end of else*/
}/*end of display function*/
```

OUTPUT:

```
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
   1. INSERT
   2. DELETE
   3. DISPLAY
   4. EXIT

Enter Your Choice::1

Enter the item to be inserted::a
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
   1. INSERT
   2. DELETE
   3. DISPLAY
   4. EXIT
```

```
Enter Your Choice::1

Enter the item to be inserted::b
 IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1. INSERT
    2. DELETE
    3. DISPLAY
    4. EXIT

Enter Your Choice::1

Enter the item to be inserted::c
 IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1. INSERT
    2. DELETE
    3. DISPLAY
    4. EXIT

Enter Your Choice::3

Contents of the circular queue are:
a         b         c
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1. INSERT
    2. DELETE
    3. DISPLAY
    4. EXIT

Enter Your Choice::1

Enter the item to be inserted::d
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1. INSERT
    2. DELETE
    3.DISPLAY
    4.EXIT

Enter Your Choice::1

Enter the item to be inserted::f
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1.INSERT
    2.DELETE
    3.DISPLAY
    4.EXIT

Enter Your Choice::3

Contents of the circular queue are:
a       b     c     d     f
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1.INSERT
     2.DELETE
     3.DISPLAY
     4.EXIT

Enter Your Choice::1 CIRCULAR
QUEUE IS FULL
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1.INSERT
    2.DELETE
    3.DISPLAY
    4.EXIT
Enter Your Choice::2
The deleted element is::a
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1.INSERT
    2.DELETE
    3.DISPLAY
    4.EXIT
Enter Your Choice::2
The deleted element is::b
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1.INSERT
    2.DELETE
    3.DISPLAY
    4.EXIT

Enter Your Choice::1

Enter the item to be inserted::x


IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1. INSERT
    2. DELETE
    3. DISPLAY
    4. EXIT

Enter Your Choice::1

Enter the item to be inserted::y
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1. INSERT
    2. DELETE
    3. DISPLAY
    4. EXIT

Enter Your Choice::1
CIRCULAR QUEUE IS FULL
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1. INSERT
    2. DELETE
    3. DISPLAY
    4. EXIT

Enter Your Choice::3

Contents of the circular queue are:
C       d    f    x    y

IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1. INSERT
    2. DELETE
    3. DISPLAY
    4. EXIT
Enter Your Choice::2
The deleted element is::c
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1. INSERT
    2. DELETE
    3. DISPLAY
    4. EXIT
Enter Your Choice::2
The deleted element is::d
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1. INSERT
    2. DELETE
    3. DISPLAY
    4. EXIT
Enter Your Choice::2
The deleted element is::f
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
    1. INSERT
    2. DELETE
    3. DISPLAY
    4. EXIT
```

```
Enter Your Choice::1

Enter the item to be inserted::z
IMPLEMENTATION OF CIRCULAR QUEUE
MENU
1. INSERT
2. DELETE
3. DISPLAY
4. EXIT

Enter Your Choice::3

Contents of the circular queue are: x    y     z
```

PROGRAM 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>
struct node
{
        char usn[12],name[20],branch[10],phno[15];
        int sem;
        struct node *link;
};
typedef struct node* NODE;
NODE start=NULL;
NODE start1=NULL;
NODE create_node()
{
        NODE ptr; ptr=(NODE)malloc(sizeof(struct node));
        if(ptr==NULL)
        {
           printf("\nINSUFFICIENT MEMORY\n");
           exit(0);
        }/*end of if*/
        printf("\n\nEnter student data such as USN, NAME,BRANCH,PHNO,SEM\n\n");
        scanf("%s%s%s%s%d",ptr->usn,ptr->name,ptr->branch,ptr->phno,&ptr->sem);
        ptr->link=NULL;
        return ptr;
}/*end of function create_node*/
NODE insert_front(NODE start)
{
     NODE ptr;
     ptr=create_node();
     if(start==NULL)
          start= ptr;
```

```
    else
    {
            ptr->link = start;
            start = ptr;
     } /*end of else*/
     return start;
} /*end of insert_front function*/
NODE insert_end(NODE start)
{
     NODE ptr,temp;
     ptr=create_node();
     if(start==NULL)
                start=ptr;
     else
    {
            temp=start;
            while(temp->link!=NULL)
            {
                    temp=temp->link;
            }/*end of inner while*/
             temp->link=ptr;
    } /*end of else*/
     return start;
} /*end of function insert_end*/
NODE delete_front(NODE start)
{
     NODE temp;
     if(start==NULL)
                printf("\n\nLIST EMPTY\n\n");
     else
    {
            temp = start;
            start=start->link;
            printf("\n\nDeleted node is\n");
            printf(" |%s|%s|%s|%s|%d|\n\n",temp->usn,temp->name,temp->branch,temp->phno, temp->sem);
            free(temp);
    }/*end of else*/
     return start;
 } /*end of function delete_front*/
```

```
NODE delete_end(NODE start)
{
     NODE p,temp;
     if(start==NULL)
     {
              printf("\n\nLIST EMPTY\n\n");
              return;
      }/*end of inner if*/
    temp=start;
    if(temp->link==NULL) /*list with only one node*/
    {
          start=NULL;
    }/*end of if*/
  else /*list with multiple nodes */
     {
               temp=start;
               while(temp->link!=NULL)
              {
                   p=temp;
                   temp=temp->link;
              } /*end of while*/
              p->link=NULL;
      }/*end of else*/
      printf("\n\nDeleted node is\n");
      printf("\n\n |%s|%s|%s|%s|%d|",temp->usn,temp->name,temp->branch, temp->phno,temp->sem);
      free(temp);
      return start;
} /*end of function delete_front*/
void display(NODE start)
{
     NODE temp;
     if(start==NULL)
              printf("\n\nLIST EMPTY\n\n");
     else
      {
        int count=0;
        temp =start;
        printf("\n\nSINGLY LINKED LIST IS: \n\n");
        while(temp!=NULL)
        {
         printf("|%s|%s|%s|%s|%d|->",temp->usn,temp->name,temp->branch, temp->phno,temp->sem);
         temp=temp->link;
         count++;
         }/*end of while*/
         printf("\n\nNUMBER OF NODE IN LIST::%d\n\n",count);
       } /*end of else*/
}/*end of function display*/

NODE list_stack(NODE stsart1)
{
     int choice;
     printf("\n\n OPERATIONS ON STACK\n\n");
     for(;;)
     {
           printf("\n\nLIST AS STACK\n\n");
           printf("\n1:PUSH\n2:POP\n3:DISPLAY\n4:EXIT\n");
           printf("\nEnter choice::\n");
           scanf("%d",&choice);
           switch(choice)
           {
                 case 1:start1=insert_front(start1);
                       break;
                 case 2:start1=delete_front(start1);
                       break;
                 case 3:display(start1);
                       break;
                default: exit(0);;
           } /*end of switch*/
     } /*end of for*/
} /* end of list_stack*/
```

```
void main()
{
    int ch,n,i;
    for(;;)
    {
            printf("\nSINGLY LINKED LIST OPERATIONS\n");
            printf("\nMENU\n");
            printf("\n\n1:List creation using Insert front\n2:Display and count\n3:Insert at end\n 4:Delete at
                    end\n5:List as Stack\n"); /*Note: write in single Line*/
            printf("Enter choice::"); scanf("%d",&ch);
            switch(ch)
            {
                case 1:printf("\n\nEnter how many student information you want enter::");
                        scanf("%d",&n);
                        for(i=1;i<=n;i++)
                        {
                            printf("\n\nEnter infomation of student %d\n\n",i);
                            start=insert_front(start);
                        } /*end of inner for*/
                        break;
                 case 2:display(start);
                        break;
                 case 3:start=insert_end(start);
                        break;
                 case 4:start=delete_end(start);
                        break;
                 case 5:start1=list_stack(start1);
                        break;
                 default:exit(0);
            }/*end of switch*/
    } /*end of for*/
} /*end of function main*/
```

OUTPUT:

```
SINGLY LINKED LIST OPERATIONS MENU
1:List creation using Insert front
2:Display and count
3:List as Stack 4:Insert
at end 5:Delete at end

Enter choice::1

Enter how many student information you want to enter:3
Enter information of student 1
Enter student data such as USN, NAME,BRANCH ,SEM, PHNO

1ks13cs001 Raj
CSE 1
9288891919

Enter information of student 2

Enter student data such as USN, NAME,BRANCH, SEM, PHNO
1KS13CS002
Sharath CSE2


8991791829

Enter information of student 3

Enter student data such as USN, NAME,BRANCH, SEM, PHNO
1KS13CS004
Bharath CSE
4
7822781426

SINGLY LINKED LIST OPERATIONS MENU
1:List creation using Insert front
2:Display and count
3:List as Stack 4:Insert
```

```
at end 5:Delete at end

Enter choice::2

SINGLY LINKED LIST IS:

|1KS13CS004|Bharath|CSE|4|7822781426|->|1KS13CS002|Sharath|CSE|2|8991791829|->|
1ks13cs001|Raj|CSE|1|9288891919|->

NUMBER OF NODE IN LIST::3
SINGLY LINKED LIST OPERATIONS MENU
1:List creation using Insert front
2:Display and count
3:List as Stack 4:Insert
at end 5:Delete at end

Enter choice::4
Enter student data such as USN, NAME,BRANCH,PHNO,SEM
1KS13CS005
Chinnu

CSE 9838712347
4

SINGLY LINKED LIST OPERATIONS MENU
1:List creation using Insert front
2:Display and count
3:List as Stack 4:Insert at
end
5:Delete at end Enter
choice::2
SINGLY LINKED LIST IS:

|1KS13CS004|Bharath|CSE|7822781426|4|->|1KS13CS002|Sharath|CSE|8991791829|2|->|
1ks13cs001|Raj|CSE|9288891919|1|->

NUMBER OF NODE IN LIST::3 SINGLY
LINKED LIST OPERATIONS MENU
```

```
1:List creation using Insert front
2:Display and count
3:List as Stack 4:Insert
at end 5:Delete at end
Enter choice::5 Deteted
node is
 |1ks13cs001|Raj|CSE|9288891919|1| SINGLY
LINKED LIST OPERATIONS MENU
1:List creation using Insert front
2:Display and count
3:List as Stack 4:Insert
at end 5:Delete at end

Enter choice::2

SINGLY LINKED LIST IS:

|1KS13CS004|Bharath|CSE|7822781426|4|->|1KS13CS002|Sharath|CSE|8991791829|2|->
NUMBER OF NODE IN LIST::2
SINGLY LINKED LIST OPERATIONS
MENU

1:List creation using Insert front
2:Display and count
3:List as Stack 4:Insert
at end 5:Delete at end
1KS13CS008
DURUTH CSE
5
8292777826
Enter choice::3 OPERATIONS ON STACK
LIST AS STACK1:PUSH
2:POP
3:DISPLAY
4:EXIT
Enter choice::
1
```

```
Enter student data such as USN, NAME,BRANCH,PHNO,SEM 1KS13CS006
VINU CSE 3
8927679912
LIST AS STACK 1:PUSH
2:POP
3:DISPLAY
4:EXIT

Enter choice::
1

Enter student data such as USN, NAME,BRANCH,PHNO,SEM
LIST AS STACK

1:PUSH
2:POP
3:DISPLAY
4:EXIT
Enter choice::
1
Enter student data such as USN, NAME,BRANCH,PHNO,SEM IKS13CS010
BHARATH CSE
8977561328
7
LIST AS STACK
1:PUSH
2:POP
3:DISPLAY
4:EXIT

Enter choice::
3
SINGLY LINKED LIST IS:

|IKS13CS010|BHARATH|CSE|8977561328|7|->|1KS13CS008|DURUTH|CSE|8292777826|5|->|
1KS13CS006|VINU|CSE|8927679912|3|->

NUMBER OF NODE IN LIST::3
```

PROGRAM 8

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>
struct node
{
            struct node *llink;
            int ssn;
            char name[20],dept[20],desi[20], phno[12];
            float sal;
            struct node *rlink;
};
typedef struct node* NODE;
NODE start=NULL;
NODE create_node()
{
        NODE ptr;
        ptr=(NODE)malloc(sizeof(struct node));
        if(ptr==NULL)
        {
            printf("\n\nINSUFFICIENT MEMORY\n\n");
            exit(0);
         } /*end of if*/
    printf("Enter employee data such as SSN, NAME,DEPARTMENT, DESIGNATION, PHONENO AND SALARY\n");
    scanf("%d%s%s%s%s%f",&ptr->ssn,ptr->name,ptr->dept,ptr->desi,ptr->phno,&ptr->sal);
   ptr->llink=NULL;
   ptr->rlink=NULL;
   return ptr;
} /*end of create_node function*/
```

```
NODE insert_front(NODE start)
{
        NODE ptr;
        ptr=create_node();
        if(start==NULL)
                start=ptr;
        else
        {
                ptr->rlink=start;
                start->llink=ptr;
                start=ptr;
        } /*end of else*/
        return start;
 } /*end of insert_front function*/

 NODE insert_end(NODE start)
{
        NODE ptr,temp;
        ptr=create_node();
        if(start==NULL)
                start=ptr;
        else
        {
                temp=start;
                while(temp->rlink!=NULL)
                {
                        temp=temp->rlink;
                }/*end of while loop*/
                temp->rlink=ptr;
                ptr->llink=temp;
        } /*end of else*/
        return start;
 } /*end of insert_end function*/
```

```
NODE delete_front(NODE start)
{
        NODE temp;
        if(start==NULL)
           printf("\n\nDoubly linked List is empty:\n\n");
        else
        {
                temp=start;
                start=start->rlink;
                if(start!=NULL) /*if dll contains more that one node this condition satisfies other wise if
                {                           dll contains only one node on moving start it becomes null */
                     start->llink=NULL;
                }
            printf("\n\nDELETED FRONT NODE IS::\n\n");
            printf("\n\n|%d|%s|%s|%s|%s|%f|\n\n",temp->ssn,temp->name,temp->dept,
            temp->desi,temp->phno,temp->sal); /* Note write in one line*/
            free(temp);
        }/*end of else*/
        return start;
    }/*end of delete_front function*/
NODE delete_end(NODE start)
{
        NODE temp,p;
        if(start==NULL)
        {
           printf("\n\nDoubly linked List is empty:\n\n");
           return;
        } /*end of if*/
        temp=start;
        if(temp->rlink==NULL) /* only one node in list */
        {
            start=NULL;
        } /*end of if*/
        else /* Multiple nodes in list */
        {
           while(temp->rlink!=NULL)
           {
                temp=temp->rlink;
            }
```

```
               p=temp->llink;
               p->rlink=NULL;
            } /* end of else */
        printf("\n\nDELETED END NODE IS::\n\n");
        printf("|%d|%s|%s|%s|%s|%f|",temp->ssn,temp->name,temp->dept,
            temp->desi,temp->phno,temp->sal); /* Note write in one line*/
   free(temp);
   return start;
} /* end of delete_end function*/

void display(NODE start)
{
        NODE temp;
        int count=0;
        if(start==NULL)
        {
                printf("\n\nDoubly linked List is empty:\n\n");
                return;
        }
        temp=start;
        printf("\n\nThe nodes of the doubly linked list are:\n\n");
        while(temp!=NULL)
        {
                printf("<->|%d|%s|%s|%s|%s|%f|",temp->ssn,temp->name,temp->dept,
                                                    temp->desi,temp->phno,temp->sal);
                temp=temp->rlink;
                count++;
        } /*end of while*/
        printf("\n\nNumber of node in doubly link list are::%d",count);
}/* end of display function */
```

```
void main()
{
        int ch,n,i;
        for(;;)
        {
                printf("\n\nMENU\n\n");
                printf("\n1:CREATE DLL of N EMPLOYEE USING INSERT
                      END\n2:DISPLAY and COUNT\n3:INSERT END\n4:DELETE
                      END\n5:INSERT FRONT\n 6:DELETE FRONT\n7:DLL AS
                      EQUEUE\n8:EXIT\n\n");
                printf("\nEnter the choice:: ");
                scanf("%d",&ch);
                switch(ch)
                {
                              case 1: printf("\n\nEnter how many employee information you want to enter::");
                                       scanf("%d",&n);
                                       for(i=1;i<=n;i++)
                                      {
                                        printf("\n\nEnter infornamtion of employee %d\n",i);
                                        start=insert_end(start);
                                      }
                                       break;
                              case 2:display(start);
                                      break;
                              case 3:start=insert_end(start);
                                       break;
                              case 4:start=delete_end(start);
                                       break;
                              case 5:start=insert_front(start);
                                       break;
                             case 6:start=delete_front(start);
                                     break;
                             case 7:printf("\n\nDEQUEUE INSERTION AND DELETION AT BOTHENDS\n\n");
                                    printf("\n\nINSERTION AT FRONT OF DEQUEUE\n\n");
                                    start=insert_front(start);
                                    display(start);
                                    printf("\n\nINSERTION AT END OF DEQUEUE\n\n");
                                    start=insert_end(start);
                                    display(start);
```

```
                                        printf("\n\nDELETION AT FRONT OF DEQUEUE\n\n");
                                        start=delete_front(start);
                                        display(start);
                                        printf("\n\nDELETION AT END OF DEQUEUE\n\n");
                                        start=delete_end(start);
                                        display(start);
                                        break;
                              default: exit(0);
                    }/* end of switch */
          }/* end of for */
}/* end of main*/
```

OUTPUT:

```
MENU

1:CREATE DLL of N EMPLOYEE USING INSERT END

2:DISPLAY and COUNT

3:INSERT END

4:DELETE END

5:INSERT FRONT

6:DELETE FRONT

7:DLL AS DEQUEUE

8:EXIT


 Enter the choice :: 3

 Enter employee data such as SSN,NAME,DEPARTMENT,DESIGNATION,PHONENO AND
 SALARY

 300

 UVW

 SALES

 DIRECTOR

85693214

30000


MENU
1:CREATE DLL of N EMPLOYEE USING INSERT END

2:DISPLAY and COUNT
```

```
3:INSERT END

4:DELETE END

5:INSERT FRONT

6:DELETE FRONT

7:DLL AS DEQUEUE
2:DISPLAY and COUNT

3:INSERT END

4:DELETE END

5:INSERT FRONT
6:DELETE FRONT

7:DLL AS DEQUEUE

8:EXIT

Enter the choice :: 5

Enter employee data such as SSN,NAME,DEPARTMENT,DESIGNATION,PHONENO AND SALARY

50

DEF PRODUCTION
MANAGER 85265452
25000

MENU

1:CREATE DLL of N EMPLOYEE USING INSERT END
```

```
8:EXIT

Enter the choice :: 2

The nodes of the doubly linked list are :

<->|50|DEF|PRODUCTION|MANAGER|85265452|25000.000000|

<->|100|ABC|SALES|MANAGER|96586985|25000.000000|

<->|200|XYZ|PRODUCTION|DIRECTOR|74125896|25000.000000|

<->|300|UVW|SALES|DIRECTOR|85693214|30000.000000|

Number of nodes in doubly link list are :: 4


MENU

1:CREATE DLL of N EMPLOYEE USING INSERT END

2:DISPLAY and COUNT

3:INSERT END

4:DELETE END

5:INSERT FRONT

6:DELETE FRONT

7:DLL AS DEQUEUE

8:EXIT

Enter the choice :: 4 DELETED
END NODE IS ::
|300|UVW|SALES|DIRECTOR|85693214|30000.000000|
MENU
1:CREATE DLL of N EMPLOYEE USING INSERT END

2:DISPLAY and COUNT

3:INSERT END

4:DELETE END
5:INSERT FRONT

6:DELETE FRONT

7:DLL AS DEQUEUE

8:EXIT

Enter the choice :: 6

DELETED FRONT NODE IS ::

|50|DEF|PRODUCTION|MANAGER|85265452|25000.000000|
MENU
1:CREATE DLL of N EMPLOYEE USING INSERT END

2:DISPLAY and COUNT

3:INSERT END

4:DELETE END

5:INSERT FRONT

6:DELETE FRONT

7:DLL AS DEQUEUE

8:EXIT
```

```
Enter the choice :: 2

The nodes of the doubly linked list are :

<->|100|ABC|SALES|MANAGER|96586985|25000.000000|

<->|200|XYZ|PRODUCTION|DIRECTOR|74125896|25000.000000|

Number of nodes in doubly link list are :: 2
MENU
1:CREATE DLL of N EMPLOYEE USING INSERT END

2:DISPLAY and COUNT

3:INSERT END

4:DELETE END

5:INSERT FRONT

6:DELETE FRONT

7:DLL AS DEQUEUE
8:EXIT

Enter the choice :: 7

DEQUEUE INSERTION AND DELETION AT BOTH ENDS
INSERTION AT FRONT OF DEQUEUE
Enter employee data such as SSN,NAME,DEPARTMENT,DESIGNATION,PHONENO AND SALARY

25

KLM SALES
EMPLOYEE 96396396
20000

The nodes of the doubly linked list are :
```

```
<->|25|KLM|SALES|EMPLOYEE|96396396|20000.000000|

<->|100|ABC|SALES|MANAGER|96586985|25000.000000|

<->|200|XYZ|PRODUCTION|DIRECTOR|74125896|25000.000000|
Number of nodes in doubly link list are :: 3
INSERTION AT END OF DEQUEUE

Enter employee data such as SSN,NAME,DEPARTMENT,DESIGNATION,PHONENO AND SALARY

250

STR

PRODUCTION
EMPLOYEE
78945602
20000

The nodes of the doubly linked list are :

<->|25|KLM|SALES|EMPLOYEE|96396396|20000.000000|

<->|100|ABC|SALES|MANAGER|96586985|25000.000000|

<->|200|XYZ|PRODUCTION|DIRECTOR|74125896|25000.000000|

<->|250|STR|PRODUCTION|EMPLOYEE|78945602|20000.000000|

Number of nodes in doubly link list are :: 4
DELETION AT FRONT OF DEQUEUE
DELETED FRONT NODE IS ::
|25|KLM|SALES|EMPLOYEE|96396396|20000.000000|

The nodes of the doubly linked list are :

<->|100|ABC|SALES|MANAGER|96586985|25000.000000|
<->|200|XYZ|PRODUCTION|DIRECTOR|74125896|25000.000000|

<->|250|STR|PRODUCTION|EMPLOYEE|78945602|20000.000000|

Number of nodes in doubly link list are :: 3
DELETION AT END OF DEQUEUE
DELETED END NODE IS ::
|250|STR|PRODUCTION|EMPLOYEE|78945602|20000.000000|

The nodes of the doubly linked list are :

<->|100|ABC|SALES|MANAGER|96586985|25000.000000|

<->|200|XYZ|PRODUCTION|DIRECTOR|74125896|25000.000000|

Number of nodes in doubly link list are :: 2
```

PROGRAM 9:

9. **Develop a Program in C for the following operation son 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

```
#include<stdio.h>
#include<stdlib.h>
#include<math.h>
 struct node
{
        int cf,px,py,pz,flag;
        struct node *link;
};
typedef struct node *NODE;

NODE  create_node()
{
        NODE  ptr;
        ptr=(NODE) malloc (sizeof(struct node));
        if(ptr==NULL)
        {
            printf("Insufficient memory\n");
            exit(0);
        }/*end of if*/
        return ptr;
} /*end of create_node*/

NODE insert_end(int cf,int x ,int y,int z,NODE head)
{
    NODE temp,ptr;
    ptr=create_node();
    ptr->cf=cf;
    ptr->px=x;
    ptr->py=y;
    ptr->pz=z;
    ptr->flag=0;
    if(head->link==head)
    {
            head->link=ptr;
            ptr->link=head;
     }  /*end of if*/
    else
    {
           temp=head->link;
          while(temp->link!=head)
                  temp=temp->link;
          temp->link=ptr;
          ptr->link=head;
    } /*end of else*/
        return head;
 } /*end of insert_end*/

void display(NODE head)
{
        NODE  temp;
        if(head->link==head)
             printf("\n\nPolynominal empty\n");
        else
        {
            temp=head->link;
            while(temp!=head)
            {
                 if(temp->cf<0)
                    printf("%dx^%dy^%dz^%d",temp->cf,temp->px,temp->py,temp->pz);
                 else
                     printf("+%dx^%dy^%dz^%d",temp->cf,temp->px,temp->py,temp->pz);
                temp=temp->link;
            } /*end of while*/
        }/*end of else*/
    }/*end of display function*/
```

```
NODE add_poly(NODE h1,NODE h2, NODE h3)
{
        NODE p1,p2;
        int cof;
        p1=h1->link;
        while(p1!=h1)
        {
                p2=h2->link;
                while(p2!=h2)
                {
                    if(p1->px==p2->px && p1->py==p2->py && p1->pz==p2->pz)
                              break;
                    p2=p2->link;
                }
                if(p2!=h2)
                {
                   cof=p1->cf+p2->cf;
                   p2->flag=1;
                   if(cof!=0)
                           h3=insert_end(cof,p1->px,p1->py,p1->pz,h3);
                }/*end of if*/
                else
                    h3=insert_end(p1->cf,p1->px,p1->py,p1->pz,h3);
                p1=p1->link;
       }/*end of outer while*/
   p2=h2->link;
    while(p2!=h2)
    {
            if(p2->flag==0)
                   h3=insert_end(p2->cf,p2->px,p2->py,p2->pz,h3);
            p2=p2->link;
     }/*end of while*/
    return h3;
}/*end of add_poly*/
```

```
NODE read_poly(NODE head)
{
    int i,cf,x,y,z;
    printf("\n\nEnter the coeffecient and exponents to stop polynomial reading enter -999\ n\n");
    for(i=1;;i++)
    {
            printf("\nEnter the %d term\n",i);
            printf("coeff="); scanf("%d",&cf);
            if(cf==-999)
                break;
             printf("pow x=");
            scanf("%d",&x);
            printf("pow y=");
            scanf("%d",&y);
            printf("pow z=");
            scanf("%d",&z);
            head=insert_end(cf,x,y,z,head);
     } /*end of for*/
    return head;
}/*end of read_poly*/
void polysum()
{
    NODE h1,h2,h3;
    h1=create_node();
    h2=create_node();
    h3=create_node();
    h1->link=h1;
    h2->link=h2;
    h3->link=h3;
    printf("\n\nEnter the first polynominal\n\n");
    h1=read_poly(h1);
    printf("\n\nEnter the second polynominal\n\n");
    h2=read_poly(h2);
    h3=add_poly(h1,h2,h3);
    printf("\n\nThe first polynominal is\n\n");
    display(h1);
    printf("\n\nSecond polynominal is\n\n");
    display(h2);
    printf("\n\nThe sum of two polynominal is\n\n");
    display(h3);
} /*end of polysum*/
```

```
void eval()
{
     NODE h,temp;
     int x,y,z,sum=0;
     h=create_node();
     h->link=h;
     printf("\n\nEnter the polynominal\n");
     h=read_poly(h);
     printf("\n\nPolynominal is\n\n");
     display(h);
     printf("\n\nEnter the values of variables x,y and z\n\n");
     scanf("%d%d%d",&x,&y,&z);
      temp=h->link;
      while(temp!=h)
      {
              sum+=temp->cf*pow(x,temp->px)*pow(y,temp->py)*pow(z,temp->pz);
              temp=temp->link;
      } /*end of while*/
     printf("\n\nThe total sum is:: %d\n",sum);
} /*end of eval function*/
void main()
{
          int ch;
          for(;;)
          {
               printf("\n\n1.Represent and Evaluate\n2.Add Two poly\n3.Exit");
               printf("\n\nEnter Your Choice:");
               scanf("%d",&ch);
              switch(ch)
              {
                         case 1: eval();
                                 break;
                          case 2:polysum();
                                  break;
                         default: exit(0);
              } /*end of switch*/
   } /*end of for*/
}/*end of main*/
```

OUTPUT:

```
1.Represent and Evaluate
2.Add Two poly
3.Exit
Enter Your Choice : 1
Enter the polynominal
Enter the coeffecient and stop polynomial reading enter -999
Enter the 1 term
coeff=6
pow x=2
pow y=2
pow z=1
Enter the 2 term
coeff=-4
pow x=0
pow y=1
pow z=5
Enter the 3 term
coeff=3
pow x=3
pow y=1
pow z=1
Enter the 4 term


coeff=2
pow x=1
pow y=5
pow z=1
Enter the 5 term
coeff=-2
pow x=1
pow y=1
pow z=3
Enter the 6 term
coeff=-999
Polynominal i s
+6x^2y^2z^1-4x^0y^1z^5+3x^3y^1z^1+2x^1y^5z^1-2x^1y^1z^3
```

```
Enter the values of variables x,y and z
2 2 3
The total sum is:: -1344
1.Represent and Evaluate
2.Add Two poly
3.Exit
Enter Your Choice : 2
Enter the first polynominal
Enter the coeffecient and stop polynomial reading enter -999
Enter the 1 term
coeff=4
pow x=2
pow y=3
pow z=3
Enter the 2 term
coeff=-6
pow x=2
pow y=2
pow z=2
Enter the 3 term
coeff=4
pow x=1
pow y=1
pow z=1
Enter the 4 term
coeff=10

pow x=0
pow y=0
pow z=0
Enter the 5 term
coeff=-999
Enter the second polynominal

Enter the coeffecient and stop polynomial reading enter -999
Enter the 1 term
coeff=5
pow x=0
pow y=3
pow z=5
Enter the 2 term
coeff=4
pow x=2
pow y=2
pow z=2
Enter the 3 term
coeff=8
pow x=1
pow y=1
pow z=1
Enter the 4 term
coeff=-999
The first polynominal is
+4x^2y^3z^3-6x^2y^2z^2+4x^1y^1z^1+10x^0y^0z^0
Second polynominal is
+5x^0y^3z^5+4x^2y^2z^2+8x^1y^1z^1
The sum of two polynominal is
+4x^2y^3z^3-2x^2y^2z^2+12x^1y^1z^1+10x^0y^0z^0+5x^0y^3z^5
1.Represent and Evaluate
2.Add Two poly
3.Exit


Enter Your Choice : 3
```

PROGRAM 10

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
{
        struct node *lchild;
        int data;
        struct node *rchild;
};
typedef struct node* NODE;
NODE root=NULL;
NODE create_node()
{
        NODE ptr;
        ptr=(NODE)malloc(sizeof(struct node));
        if(ptr==NULL)
        {
                printf("Insufficient memory\n");
                exit(0);

        }
        else
        {
                printf("Enter data:: ");
                scanf("%d",&ptr->data);
                ptr->lchild=ptr->rchild=NULL;
        }/* end of else*/
    return ptr;
}/* end of create_node function*/
```

```
NODE create_bst(NODE root)
{
        NODE ptr, temp, p;
        ptr=create_node();
        if(root==NULL)
        {
                root=ptr;
                return root;
        }/* end of if*/
        p=NULL;
        temp=root;
        while(temp!=NULL)
        {
                p=temp;
                if(ptr->data==temp->data)
                {
                        printf("Duplicate items are not allowed\n\n");
                        free(ptr);
                        return root;
                }/* end of if*/
                if(ptr->data<temp->data)
                temp=temp->lchild;
                else
                temp=temp->rchild;
        }/* end of while*/
        if(ptr->data<p->data)
                p->lchild=ptr;
        else
                p->rchild=ptr;
        return root;
}/* end of create_bst*/
```

```
void inorder(NODE t)
{
	if(t!=NULL)
	{
		inorder(t->lchild);
		printf("%d\t",t->data);
		inorder(t->rchild);
	}/* end of if*/
}/* end of inorder*/

void preorder(NODE t)
{
	if(t!=NULL)
	{
		printf("%d\t",t->data);
		preorder(t->lchild);
		preorder(t->rchild);
	}/* end of if*/
}/* end of preorder*/

void postorder(NODE t)
{
	if(t!=NULL)
	{
		postorder(t->lchild);
		postorder(t->rchild);
		printf("%d\t",t->data);
	}/* end of if*/
}/* end of postorder*/

void traverse(NODE root)
{
	if(root==NULL)
		printf("Empty tree\n\n");
	else
	{
		printf("\n\nPreorder traversal:\t");
		preorder(root);
```

```
                printf("\n\nInorder traversal:\t");
                inorder(root);
                printf("\n\nPostorder traversal:\t");
                postorder(root);
        }/* end of else*/
  }/* end of traversal function*/

void search_bst(NODE root)
{
        int key,flag=0;
        NODE temp;
        printf("Enter key to search in bst::");
        scanf("%d",&key);
        if(root==NULL)
        {
                printf("BST IS EMPTY\n\n ");
                return;
        }
        else
        {
                temp=root;
                while(temp!=NULL)
                {
                        if(key==temp->data)
                        {
                                printf("Key found\n\n");
                                flag=1;
                                break;
                        }/* end of if*/
                        else if(key<temp->data)
                                temp=temp->lchild;
                        else
                                temp=temp->rchild;
                }/* end ofwhile*/
        }/* end of outer else*/
        if(flag==0)
                printf("Key not found\n\n");
}/* end of search function*/
```

```
void main()
{
        int ch;
        for(;;)
        {
                printf("\n\nOPERATIONS ON BST\n\n");
                printf("\n\n1:CREATE BST \n2:TRAVERSE BST\n3:SEARCH\n4:EXIT\n\n");
                printf("Enter your choice::");
                scanf("%d",&ch);
                switch(ch)
                {
                        case 1:root=create_bst(root);
                                break;
                        case 2: traverse(root);
                                break;
                        case 3:search_bst(root);
                                break;
                        default:exit(0);
                }/* end of switch*/
        }/* end of for*/
}/* end of main*/
```

OUTPUT:

```
OPERATIONS ON BST

1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
Enter your choice::1
Enter data:: 6

OPERATIONS ON BST


1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
```

```
Enter your choice::1
 Enter data:: 9
OPERATIONS ON BST
1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
Enter your choice::1
Enter data:: 5
OPERATIONS ON BST
 1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
Enter your choice::1
Enter data:: 2
OPERATIONS ON BST
 1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
Enter your choice::1
Enter data:: 8
OPERATIONS ON BST
1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
Enter your choice::1
Enter data:: 15
OPERATIONS ON BST

1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
Enter your choice::1
Enter data:: 24
```

```
OPERATIONS ON BST
]1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
Enter your choice::1
 Enter data:: 14
OPERATIONS ON BST
1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
Enter your choice::1
Enter data:: 7
OPERATIONS ON BST
 1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
Enter your choice::1
 Enter data:: 8
Duplicate items are not allowed
OPERATIONS ON BST
1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
Enter your choice::1
Enter data:: 5
Duplicate items are not allowed
OPERATIONS ON BST

1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
Enter your choice::1
 Enter data:: 2
```

```
Duplicate items are not allowed
OPERATIONS ON BST
1:CREATE BST
2:TRAVERSE BST
3: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

OPERATIONS ON BST
 1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT

Enter your choice::3
Enter key to search in bst::24
Key found

OPERATIONS ON BST
1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT

Enter your choice::3
Enter key to search in bst::10
Key not found

OPERATIONS ON BST
1:CREATE BST
2:TRAVERSE BST
3:SEARCH
4:EXIT
```

PROGRAM 11

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

11 a) BFS PROGRAM

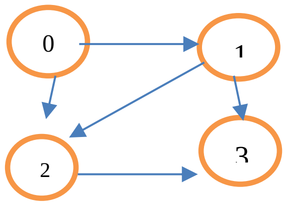
```
 #include<stdio.h>
 #include<stdio.h>
 void bfs(int a[10][10],int n,int u)
 {
      int front,rear,q[10],visited[10],v,i;
      for(i=0;i<n;i++)
              visited[i]=0;
      front=0;
      rear=-1;
      printf("\nThe nodes visited from %d are::\n",u);
      q[++rear]=u;
      visited[u]=1;
      printf("%d\t",u);
      while(front<=rear)
      {
          u=q[front++];
          for(v=0;v<n;v++)
          {
                 if(a[u][v]==1&&visited[v]==0)
                 {
                          printf("%d\t",v);
                          visited[v]=1;
                          q[++rear]=v;
                   }/* end of if*/
          }/* end of for*/
    }/* end of while*/
}/* end of bfs function*/
```

```
 void main()
{
      int a[10][10],n,source,i,j;
      printf("\nEnter number of vertices::");
      scanf("%d",&n);
      printf("\nEnter the graph as adjacency matrix\n");
      for(i=0;i<n;i++)
     {
           for(j=0;j<n;j++)
                 scanf("%d",&a[i][j]);
      }/*end of outer for*/
     printf("Enter source vertex::");
    scanf("%d",&source);
    printf("\nBFS OF GIVEN GRAPH\n");
    bfs(a,n,source);
}
```

OUTPUT:

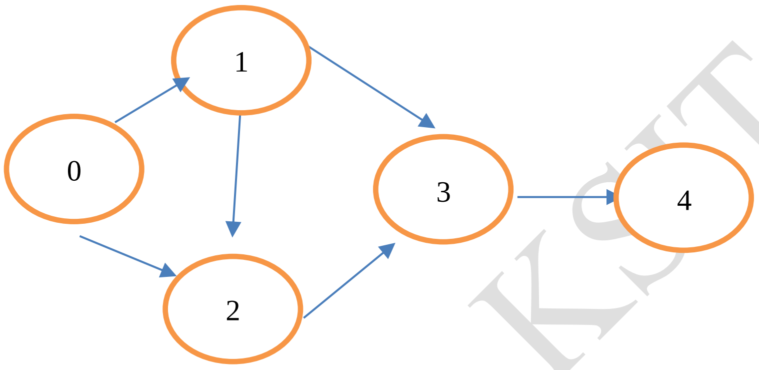
```
1)
Enter number of vertices::4

Enter the graph as adjacency matrix
0 1 1 0
0 0 1 1
0 0 0 1
0 0 0 0
Enter source vertex::0
BFS OF GIVEN GRAPH
The nodes visited from 0 are::
0       1    2    3
```

Graph 1



2)

```
Enter number of vertices::5
Enter the graph as adjacency matrixGraph 2
0 1 1 0 0
0 0 1 1 0
0 0 0 1 0
0 0 0 0 1
0 0 0 0 0
Enter source vertex::1
BFS OF GIVEN GRAPH
The nodes visited from 1 are::
1        2        3       4
```



11 b) DFS PROGRAM

```
#include<stdio.h>
int a[10][10],visited[10],n;

void dfs(int u)
{
        int v;
        visited[u]=1;
        printf("%d\t",u);
        for(v=0;v<n;v++)
        {
                if(a[u][v]==1&&visited[v]==0)
                dfs(v);
        }/* end of if*/
}/* end of dfs*/
void main()
{
        int source,i,j;
        printf("Enter number of vertices::");
        scanf("%d",&n);
        printf("\n\nEnter graph as adjacency matrix form\n\n");
        for(i=0;i<n;i++)
        {
                for(j=0;j<n;j++)
                        scanf("%d",&a[i][j]);
        }/* end of for*/
        for(i=0;i<n;i++)
                visited[i]=0;
        printf("\n\nEnter source vertex::");
        scanf("%d",&source);
        printf("\nDFS of given graph\n");
        printf("Node visited from source node %d are::\n",source);
        dfs(source);
}/* end of main*/
```

OUTPUT:

1)
```
Enter number of vertices::4


Enter graph as adjacency matrix form

0 1 1 0
0 0 1 1                    (for Graph 1)
0 0 0 0
0 0 0 0
Enter source vertex::0
DFS of given graph
Node visited from source node 0 are::
0       1     2     3
```

2)
```
Enter number of vertices::5
Enter graph as adjacency matrix form
0 1 1 0 0
0 0 1 1 1
0 0 0 1 0
0 0 0 0 1
0 0 0 0 0

                         (for Graph 2)

Enter source vertex::0
DFS of given graph
Node visited from source node 0 are::
0 1 2 3 4
```

PROGRAM 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 →L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L. Resolve the collision (if any) using linear probing.

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
struct record
{
        int empno,flag; // employee number is the key- K with 4 digits
        char name[10];
}emp[100];
int hash(int m)
{
    int r;
    r=m%100;
    return r;
}
void main()
{
    int m,k,eno,loc,i,n,j;
    char name[10];
    FILE *in;
    printf("\nEnter no of records to read from file: ");
    scanf("%d",&n);
    in = fopen("input.txt", "r");
    if(n<=10)
    {
            for(k=0;k<100;k++)
                    emp[k].flag=0;
            for(i=0;i<n;i++)
            {
                fscanf(in,"%d%s",&eno,name);
                loc=hash(eno);
```

```
                 if(emp[loc].flag==0)
                {
                            printf("\nRecord:%d is mapped to address:%d\n",i,loc);
                            emp[loc].empno=eno;
                            emp[loc].flag=1;
                            strcpy(emp[loc].name,name);
                 }/* end of inner if*/
                 else
                 {
                        printf("\n\nCollision occured for record %d resolved using linear  probing\n\n",i);
                        for(j=loc+1;j<100;j++)
                        {
                                if(emp[j].flag==0)
                                {
                                        printf("\nRecord:%d is at address:%d\n",i,j);
                                        strcpy(emp[j].name,name);
                                        emp[j].empno=eno;
                                        emp[j].flag=1;
                                        break;
                                } /* end of inner if*/
                        }/* end of for*/
                        if(j>=100)
                        {
                                printf("HASH TABLE IS FULL\n");
                                printf("\n ------------------------\n");
                        }/* end of if*/
                  }/* end of inner else*/
          }/* end of for*/
          fclose(in);
          printf("\n\nThe Hash Table Content is: ");
          for(i=0;i<100;i++)
          {
                if(emp[i].flag==1)
                        printf("\n%d\t%d\t%s",i,emp[i].empno,emp[i].name);
                else
                       printf("\n####");
          }/* end of for*/
      }/* end of if*/
          else
              printf("\nFile is containing only 10 records\n\n");
  }/* end of main*/
```

NOTE: Create a notepad file with name input.txt, and store employee no and name. Save the file in the same folder as your program folder.

OUTPUT:

```
Enter no of records to read from file: 10
Record:0 is mapped to address:1 Record:1 is
mapped to address:10
Collision occured for record 2 resolved using linear probing
Record:2 is at address:11
Collision occured for record 3 resolved using linear probing
Record:3 is at address:12
Record:4 is mapped to address:36

9999Collision occured for record 5 resolved using linear probing
Record:5 is at address:37
Record:6 is mapped to address:56
Collision occured for record 7 resolved using linear probing
Record:7 is at address:57
Record:8 is mapped to address:66
Record:9 is mapped to address:89

The Hash Table Content is:

Address Empno Name
####
1
####
1201 aaa
####
####
####
####
####
####
####
10 2410 bbb
11 3510 ccc
```

```
12 4610 ddd
####
####
####
####
####
####
####
####
####
####
####
####
####
####
####
####
####
####
####
####
####
####
####
36 7836 Eee
37 8936 Fff
####
####
####
####
####
####
####
####
####
####
####
####
####
```

```
####
####
####
####
####
56  1356 Ggg
57  3456  Hhh
####
####
####
####
####
####
####
####
66  1466  Iii
####
####
####
####
####
####
####
####
####
####
####

####
####
####
####
####
####
####
####
####
89 4589 jjj
```

####

####

####

####

####

####

####

####

####

####

Possible Viva questions

1.What are some of the applications for the tree data structure?

1- Manipulation of the arithmetic expressions.

2- Symbol table construction.

3- Syntax analysis.

2. What is the data structures used to perform recursion?

Stack. Because of its LIFO (Last In First Out) property it remembers its 'caller' so knows whom toreturn when the function has to return. Recursion makes use of system stack for storing the returnaddresses of the function calls.

1. Convert the expression ((A + B) * C - (D - E) ^ (F + G)) to equivalent Prefix and Postfix notations.

1. **Prefix Notation:** ^ - * +ABC - DE + FG

2. **Postfix Notation:** AB + C * DE - - FG + ^

4. In tree construction which is the suitable efficient data structure? Linked list is the suitable efficient data structure.

5. What are the types of Collision Resolution Techniques and the methods used in each of the type?

6. Open addressing (closed hashing), The methods used include: Overflow block.

7. Closed addressing (open hashing), The methods used include: Linked list, Binary tree.

8 SSList out the areas in which data structures are applied extensively?

1. Compiler Design,
2. Operating System,
3. Database Management System,
4. Statistical analysis package,
5. Numerical Analysis,
6. Graphics,
7. Artificial Intelligence,
8. Simulation

7. What is a linked list?

A linked list is a linear collection of data elements, called nodes, where the linear order is given by pointers. Each node has two parts first part contain the information of the element second part contains the address of the next node in the list.

8. What are the advantages of linked list over array (static data structure)?

   The disadvantages of array are unlike linked list it is expensive to insert and delete elements in the array One can’t double or triple the size of array as it occupies block of memory space. In linked list each element in list contains a field, called a link or pointer which contains the address of the next element Successive element’s need not occupy adjacent space in memory.

9. Can we apply binary search algorithm to a sorted linked list, why?

No we cannot apply binary search algorithm to a sorted linked list, since there is no way of indexing the middle element in the list. This is the drawback in using linked list as a data structure

10. What do you mean by overflow and underflow?
11. When new data is to be inserted into the data structure but there is no available space i.e. free storage list is empty this situation is called overflow.

When we want to delete data from a data structure that is empty this situation is called underflow.

12. What is a queue?1 A queue is an ordered collection of items from which items may be deleted at one end (front end) and items inserted at the other end (rear end).It obeys FIFO rule there is no limit to the number of elements a queue contains.
13. What is a priority queue? The priority queue is a data structure in which the intrinsic ordering of the elements (numeric or alphabetic) Determines the result of its basic operation. It is of two types i) Ascending priority queue- Here smallest item can be removed (insertion is arbitrary) ii) Descending priority queue- Here largest item can be removed (insertion is arbitrary)
14. What are the disadvantages of sequential storage?
    .Fixed amount of storage remains allocated to the data structure even if it contains less element. No more than fixed amount of storage is allocated causing overflow
15. Define circular list?

In linear list the next field of the last node contain a null pointer, when a next field in the last node contain a pointer back to the first node it is called circular list.
Advantages – From any point in the list it is possible to reach at any other point

16. What are the disadvantages of circular list?
    i) We can't traverse the list backward ii) If a pointer to a node is given we cannot delete the node
17. Define double linked list?

It is a collection of data elements called nodes, where each node is divided into three parts

i) An info field that contains the information stored in the node
ii) Left field that contains pointer to node on left side
iii) Right field that contain pointer to node on right side

16. For an undirected graph with n vertices and e edges, the sum of the degree of each vertex is equal to Ans:2e
17. A full binary tree with 2n+1 nodes contain Ans: n non-leaf nodes
18. If a node in a BST has two children, then its inorder predecessor has Ans: no right child
19. A binary tree in which if all its levels except possibly the last, have the maximum number of nodes and all the nodes at the last level appear as far left as possible, is known as
    Ans: complete binary tree
20. A linear list of elements in which deletion can be done from one end (front) and insertion can take place only at the other end (rear) is known as a
    Ans: queue
21. In a circular linked list

Ans: there is no beginning and no end.

22. The data structure required for Breadth First Traversal on a graph is Ans: queue

23. The data structure required to evaluate a postfix expression is (A) queue (B) stack (C) array (D) linked-list
    Ans: Stack
24. The data structure required to check whether an expression contains balanced parenthesis is
    Ans: Stack

25. The number of leaf nodes in a complete binary tree of depth d is Ans: 2d
26. A linear collection of data elements where the linear node is given by means of pointer called (Ans: linked list
27. Representation of data structure in memory is known as: Ans: abstract data type
28. If the address of A[1][1] and A[2][1] are 1000 and 1010 respectively and each element occupies 2 bytes then the array has been stored in________________________order.
    Ans: row major
29. An adjacency matrix representation of a graph cannot contain information of : Ans: parallel edges