VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Belagavi-590018, Karnataka

VIDYA VIKAS INSTITUTE OF ENGINEERINGAND TECHNOLOGY

MYSURU-570028

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LAB MANUAL
(2025-26)

Subject Name: DATA STRUCTURES LABORATORY
Subject Code: BCSL305
Semester: III Sem

Prepared By,

Tejeshwini C S *B.E., M.Tech*
Assistant Professor

Institute Vision and Mission

Institute Vision and Mission

Institute Vision

Our vision is to provide learning opportunities, ensuring excellence in education, research and facilitate an inspiring world class environment to encourage creativity. The Institute is committed to disseminating knowledge, and through its ingenuity, bring this knowledge to bear on the world's great challenges. VVIET is dedicated to providing its students with an education that combines academic study and the excitement of discovery kindled by a diverse campus community.

Institute Mission

- Offer highest professional and academic standards in terms of personal growth and satisfaction, and promote growth and value to our research sponsors.
- Provide students a platform where independent learning and scientific study are encouraged with emphasis on latest engineering techniques.
- Encourage students to implement applications of engineering with a focus on societal needs for the betterment of communities.
- Empower students with vast technical and life skills to raise their stakes of getting placements in top reputed companies.
- Create a benchmark in the areas of research, education and public outreach.

Department Vision and Mission

Department Vision and Mission

Department Vision

Our vision is to strive for excellence in intellectual inquiry and empower students with knowledge to overcome complexities in the operations and strategies of any engineering framework.

Department Mission

Imparting quality education by adopting the well-designed curriculum under VTU, Karnataka in tune with the challenging software needs of the industry.

Providing state of art research facilities to generate knowledge and develop technologies in the thrust areas of Information science and engineering.

Developing linkages with well recognized organizations to strengthen industry-academia relationships for mutual benefits.

Program Educational Objectives

Program Educational Objectives

PEO 1: To demonstrate analytical and technical problem solving abilities.

PEO 2: To conversant in the developments of information Technology, leading towards the employability and higher studies.

PEO 3: To engage in research and development leading to new innovations and products.

Program Outcomes

Program Outcomes (POs)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, research literature, and Analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis ofthe information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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

Program Specific Outcomes

Program Specific Outcomes

PSO 1: Apply Software Engineering Principles and Practices to provide reliable software solutions

PSO 2: Design and Develop Mobile and Web-based Computational systems for realistic societal challenges and constraints

PSO 3: Empower students with the capability of using modern tools to develop software system

DO's and DON'Ts

DO's and DON'Ts

Do's

Students should be in proper uniform and dress code with identity cards in the laboratory. Students should bring their observation, manual and record compulsorily.

Students should maintain discipline in the laboratory.

Students are required to handle all the equipment's/Computers properly. Students are required to follow the safety precautions.

Enter the lab in time as per the given time table. Enter time-in and time-out in log book.

Comply with the instructions given by faculty and instructor. Arrange the chairs/ equipment's before leaving the lab.

Take signature in the observation, before leaving the lab.

Don'ts

Mobile phones are strictly banned. Ragging is punishable.

Do not turn on the power supply before verification of the circuits by the Batch in Charge. Do not operate any peripherals or accessories without supervision.

Avoid stepping on computer cables and electrical wires.Do not walk around in the lab unnecessarily. Do not go out of the lab without permission.

Specification of the Laboratory

SI.NO	MAJOREQUPIMENT/SYSTEM	SPECIFICATION
1	Computer	CORE I5 8GB RAM 160 GB HDD17inchMONITOR
2	SOFTWARE	Ubuntu

VIDYA VIKAS INSTITUTE OF ENGINEERING & TECHNOLOGY,
#127-128, Mysore-Bannur Road, Aalanahally Post, Mysuru 570 028
DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERING

Syllabus

DATA STRUCTURES LABORATORY
SEMESTER – III

Course Code	**BCSL305**	**CIE Marks**	50
Number of Contact Hours/Week	0:0:2	**SEE Marks**	50
Total Number of Lab Contact Hours	28	**Exam Hours**	03

Credits – 1

Course Learning Objectives:

This laboratory course enables students to get practical experience in design, develop, implement, analyze and evaluation/testing of

- Dynamic memory management
- Linear data structures and their applications such as stacks, queues and lists
- Non-Linear data structures and their applications such as trees and graphs

Descriptions (if any):

- Implement all the programs in "C " Programming Language and Linux OS.

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 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.
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.
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

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.
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

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
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
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
9.	Develop a Program in C for the following operationson Singly Circular Linked List (SCLL) with header nodes a. Represent and Evaluate a Polynomial $P(x,y,z) = 6x^2y^2z-4yz^5+3x^3yz+2xy^3z-2xyz^3$ 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
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
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

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.

Laboratory Outcomes: The student should be able to:

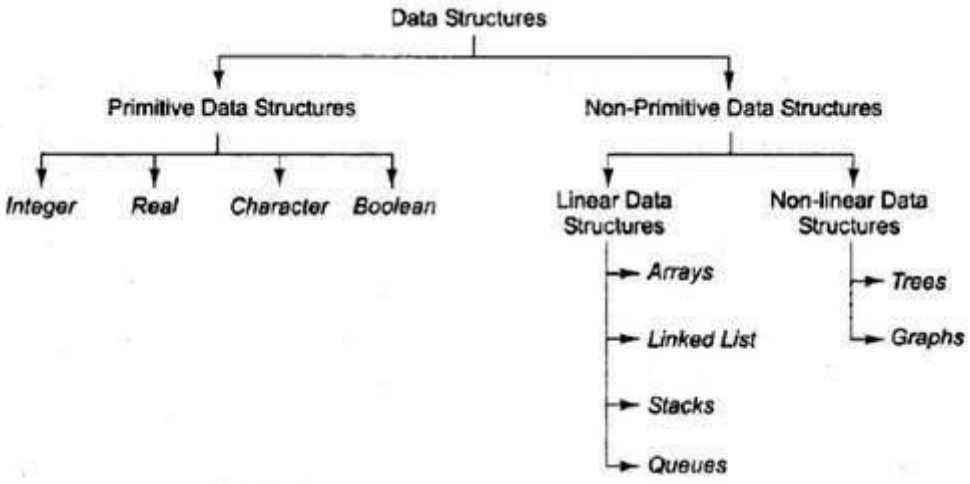
- Analyze various linear and non-linear data structures
- Demonstrate the working nature of different types of data structures and their applications
- Use appropriate searching and sorting algorithms for the give scenario.
- Apply the appropriate data structure for solving real world problems

Conduct of Practical Examination:

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

INTRODUCTION TO DATA STRUCTURES

Data Structure is defined as the way in which data is organized in the memory location. There are 2 types of data structures:



Linear Data Structure:

In linear data structure all the data are stored linearly or contiguously in the memory. All the data are saved in continuously memory locations and hence all data elements are saved in one boundary. A linear data structure is one in which we can reach directly only one element from another while travelling sequentially. The main advantage, we find the first element, and then it's easy to find the next data elements. The disadvantage, the size of the array must be known before allocating the memory.

The different types of linear data structures are:

- Array
- Stack
- Queue
- Linked List

Non-Linear Data Structure:

Every data item is attached to several other data items in a way that is specific for reflecting relationships. The data items are not arranged in a sequential structure.

The various types of non-linear data structures are:

- Trees
- Graphs

PROGRAM – 01

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.

ABOUT THE EXPERIMENT:

An Array is a collection of similar / same elements. In this experiment the array can be represented as one / single dimensional elements.

Structure a way to group data that permits the data to vary in type. This mechanism is called the structure, for short **struct**.

A structure (a record) is a collection of data items, where each item is identified as to its type and name.

Syntax:

```
struct
{
data_type member 1;
data_type member 2;
……
……
data_type member n;
} variable_name;
```

Menu driven program in c - language to perform various operations are implemented with the help of user defined functions as followings;

create()
read()
display()

PROGRAM CODE 1A:

```
#include <stdio.h>
#include <string.h>
// Define a structure to represent a day

struct Day {

    char name[20];

    int date;

    char activity[100];

};

int main()
```

```
{
    // Declare an array of 7 elements to represent the calendar
    struct Day calendar[7];
   // Initialize the calendar with sample data
    strcpy(calendar[0].name, "Monday");
    calendar[0].date = 1;
    strcpy(calendar[0].activity, "Work from 9 AM to 5 PM");

    strcpy(calendar[1].name, "Tuesday");
    calendar[1].date = 2;
    strcpy(calendar[1].activity, "Meeting at 10 AM");

    strcpy(calendar[2].name, "Wednesday");
    calendar[2].date = 3;
    strcpy(calendar[2].activity, "Gym at 6 PM");

    strcpy(calendar[3].name, "Thursday");
    calendar[3].date = 4;
    strcpy(calendar[3].activity, "Dinner with friends at 7 PM");

    strcpy(calendar[4].name, "Friday");
    calendar[4].date = 5;
    strcpy(calendar[4].activity, "Movie night at 8 PM");

    strcpy(calendar[5].name, "Saturday");
    calendar[5].date = 6;
    strcpy(calendar[5].activity, "Weekend getaway");

    strcpy(calendar[6].name, "Sunday");
    calendar[6].date = 7;
    strcpy(calendar[6].activity, "Relax and recharge");
```

```
    // Print the calendar
    printf("Calendar for the week:\n");
    for (int i = 0; i < 7; i++) {
        printf("%s (Date: %d): %s\n", calendar[i].name, calendar[i].date, calendar[i].activity);
    }
    return 0;
}
```

SAMPLE OUTPUT 1:

Calendar for the week:

Monday (Date: 1): Work from 9 AM to 5 PM
Tuesday (Date: 2): Meeting at 10 AM

Wednesday (Date: 3): Gym at 6 PM

Thursday (Date: 4): Dinner with friends at 7 PM

Friday (Date: 5): Movie night at 8 PM

Saturday (Date: 6): Weekend getaway

Sunday (Date: 7): Relax and recharge

PROGRAM CODE 1B:

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.

PROGRAM CODE

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

// Define a structure to represent a day
struct Day {
    char name[20];
    int date;
    char activity[100];
};

// Function to create the calendar
void create(struct Day calendar[7]) {
```

```
    for (int i = 0; i < 7; i++) {
        printf("Enter details for %s:\n", calendar[i].name);
        printf("Date: ");
        scanf("%d", &calendar[i].date);
        printf("Activity: ");
        scanf(" %[^\n]", calendar[i].activity);

    }
}

// Function to read data from the keyboard
void read(struct Day calendar[7]) {
    FILE *file = fopen("calendar.txt", "r");
    if (file == NULL) {
        printf("Error opening the file.\n");
        return;
    }

    for (int i = 0; i < 7; i++) {
        fscanf(file, "%d", &calendar[i].date);
        fscanf(file, " %[^\n]", calendar[i].activity);
    }

    fclose(file);
}

// Function to display the calendar
void display(struct Day calendar[7]) {
    printf("Calendar for the week:\n");
    for (int i = 0; i < 7; i++) {
        printf("%s (Date: %d): %s\n", calendar[i].name, calendar[i].date, calendar[i].activity);
    }
}

int main() {
```

```
    struct Day calendar[7];

    // Initialize the names of the days
    strcpy(calendar[0].name, "Monday");
    strcpy(calendar[1].name, "Tuesday");
    strcpy(calendar[2].name, "Wednesday");
    strcpy(calendar[3].name, "Thursday");
    strcpy(calendar[4].name, "Friday");
    strcpy(calendar[5].name, "Saturday");
    strcpy(calendar[6].name, "Sunday");
    int choice;

    printf("1. Create Calendar\n");
    printf("2. Read Calendar from File\n");
    printf("Enter your choice: ");
    scanf("%d", &choice);

    switch (choice) {
        case 1:
            create(calendar);
            break;
        case 2:
            read(calendar);
            break;
        default:
            printf("Invalid choice.\n");
            return 1;
    }

display(calendar);

    return 0;
}
```

SAMPLE OUTPUT 1:

1. Create Calendar

2. Read Calendar from File

Enter your choice: 1

Enter details for Monday:

Date: 07/01/2001

Activity: Enter details for Tuesday:

Date: JAVA

Activity: Enter details for Wednesday:

Date: PYTHON

Activity: Enter details for Thursday:

Date: C/C++

Activity: Enter details for Friday:

Date: GAMING

Activity: Enter details for Saturday:

Date: APTITUDE

Activity: Enter details for Sunday:

Date: GENERAL KNOWLEDGE

Activity: Calendar for the week:

Monday (Date: 7): /01/2001

Tuesday (Date: 1417934205): JAVA

Wednesday (Date: 32543): PYTHON

Thursday (Date: 0): C/C++

Friday (Date: 0): GAMING
Saturday (Date: 832): APTITUDE

Sunday (Date: 0): GENERAL KNOWLEDGE

PROGRAM - 02

2. Design, Develop and Implement a Program in C for the following operations on Strings a. Read a main String (STR), a Pattern String (PAT) and a 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.

ABOUT THE EXPERIMENT:

Strings are actually one-dimensional array of characters terminated by a null character '\0'. Thus a null-terminated string contains the characters that comprise the string followed by a null.

The following declaration and initialization create a string consisting of the word "Hello". To hold the null character at the end of the array, the size of the character array containing the string is one more than the number of characters in the word "Hello." char greeting[6] = {'H', 'e', 'l', 'l', 'o', '\0'}; If you follow the rule of array initialization then you can write the above statement as follows: char greeting[] = "Hello"; C language supports a wide range of built-in functions that manipulate null-terminated.strings as follows:

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

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

strlen(s1); Returns the length of string s1.

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

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

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

PROGRAM CODE:

```
#include<stdio.h>

void main()

{

char STR[100],PAT[100],REP[100],ans[100];

int i,j,c,m,k,flag=0;

printf("\nEnter the MAIN string: \n"); gets(STR);

printf("\nEnter a PATTERN string: \n"); gets(PAT);

printf("\nEnter a REPLACE string: \n"); gets(REP);

i = m = c = j = 0; while ( STR[c] != '\0') {

// Checking for Match

if ( STR[m] == PAT[i]
```

```
) { i++; m++;
flag=1;
if ( PAT[i] == '\0')
{
//copy replace string in ans string
for(k=0; REP[k] != '\0';k++,j++)
ans[j] = REP[k];
i=0;
c=m;
}
}
else //mismatch
{
ans[j] = STR[c];
j++; c++;
m = c; i=0;
}
}
if(flag==0)
{
printf("Pattern doesn't found!!!");
}
else
{
ans[j] = '\0';
printf("\nThe RESULTANT string is:%s\n" ,ans);
}
}
```

SAMPLE OUTPUT 1:

Enter the MAIN string: good morning

Enter a PATTERN string: morning

Enter a REPLACE string: evening

The RESULTANT string is: good evening

SAMPLE OUTPUT 2:

Enter the MAIN string: hi vviet

Enter a PATTERN string: bye

Enter a REPLACE string: hello

Pattern doesn't found!!

PROGRAM - 03

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

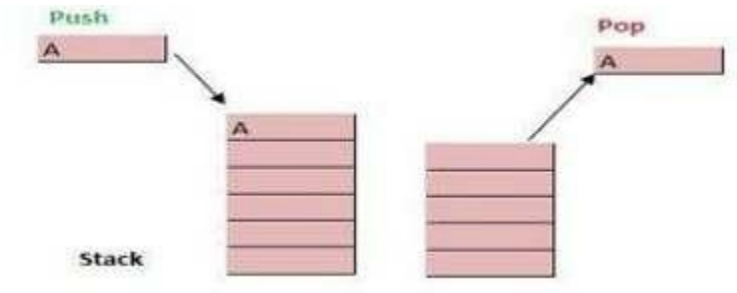
e. Display the status of Stack

f. Exit

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

ABOUT THE EXPERIMENT:

A stack is an abstract data type (ADT), commonly used in most programming languages. It is named stack as it behaves like a real-world stack. A real-world stack allows operations at one end only. For example, we can place or remove a card or plate from top of the stack only. Likewise, Stack ADT allows all data operations at one end only. At any given time, we can only access the top element of a stack. This feature makes it LIFO data structure. LIFO stands for Last-in-first-out. Here, the element which is placed (inserted or added) last is accessed first. In stack terminology, insertion operation is called PUSH operation and removal operation is called POP operation. A stack can be implemented by means of Array, Structure, Pointer and Linked-List. Stack can either be a fixed size one or it may have a sense of dynamic resizing. Here, we are going to implement stack using arrays which makes it a fixed size stack implementation.



Basic Operations:

• push() - pushing (storing) an element on the stack.

• pop() -removing (accessing) an element from the stack. To use a stack efficiently we need to check status of stack as well. For the same purpose, the following functionality is added to stacks;

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

- isFull() − check if stack is full.
- isEmpty() − check if stack is empty.

PROGRAM CODE

```
#include<stdlib.h>
#include<stdio.h>
#include<string.h>
#define max_size 5
int stack[max_size],top=-1,flag=1;

int i,temp,item,rev[max_size],num[max_size];
void push();
void pop();
void display();
void pali();
int main()
{
int choice;
printf("\n\n--------STACK OPERATIONS------- \n");
printf("1.Push\n");
printf("2.Pop\n"); printf("3.Palindrome\n"); printf("4.Display\n"); printf("5.Exit\n");
printf(" ");
while(1)
{
printf("\nEnter your choice:\t");
scanf("%d",&choice);
switch(choice)
{
case 1: push();break;
case 2: pop();
if(flag)
printf("\nThe poped element: %d\t",item);
temp=top; break;
```

```
case 3: pali();
top=temp; break;
case 4: display(); break;
case 5: exit(0); break;
default: printf("\nInvalid choice:\n"); break;
}

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

```
item=stack[top];
top=top-1;

}
}
void pali()
{ i=0;
if(top==-1)
{
printf("Push some elements into the stack first\n");
}
else
{
while(top!=-1)
{
rev[top]=stack[top]; pop();
}
top=temp; for(i=0;i<=temp;i++)
{
if(stack[top--]==rev[i])
{
if(i==temp)
{
printf("Palindrome\n"); return;
}
}
}
printf("Not Palindrome\n");
}
}
void display()
{

int i; top=temp;
```

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

SAMPLE OUTPUT 1:

```
linux:~/dslab # gedit stack.c linux:~/dslab # cc stack.c
--------STACK OPERATIONS----------
1.Push
2.Pop
3.Palindrome
4.Display
5.Exit
- - - - - - - - - - - - - - -

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

Enter your choice: 1
Enter the element to be inserted: 5
Enter your choice: 2
The poped element: 5
```

Enter your choice: 4

The stack elements are: 1 2 1

Enter your choice: 3

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

Enter your choice: 5

Exit

SAMPLE OUTPUT 2:

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

1. Push

2.Pop

3.Palindrome

4.Display

5.Exit

Enter your choice: 1

Enter the element to be inserted: 10

Enter your choice: 1

Enter the element to be inserted: 20

Enter your choice: 1

Enter the element to be inserted: 10

Enter your choice: 1

Enter the element to be inserted: 50

Enter your choice: 2

The poped element: 50

Enter your choice: 4

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

Enter your choice: 5

Exit

PROGRAM - 04

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.

ABOUT THE EXPERIMENT:

Infix: Operators are written in-between their operands. Ex: X + Y Prefix: Operators are written before their operands. Ex: +X Y Postfix: Operators are written after their operands. Ex: XY+

Examples of Infix, Prefix, and Postfix

Infix Expression	Prefix Expression	Postfix Expression
A + B	+ A B	A B +
A + B * C	+ A * B C	ABC*+

Expression	Stack	Output	Comment
5^E+D*(C^B+A)	Empty	-	Initial
^E+D*(C^B+A)	Empty	5	Print
E+D*(C^B+A)	^	5	Push
+D*(C^B+A)	^	5E	Push
D*(C^B+A)	+	5E^	Pop And Push
*(C^B+A)	+	5E^D	Print
(C^B+A)	+*	5E^D	Push
C^B+A)	+*(	5E^D	Push
^B+A)	+*(	5E^DC	Print
B+A)	+*(^	5E^DC	Push
+A)	+*(^	5E^DCB	Print
A)	+*(+	5E^DCB^	Pop And Push
)	+*(+	5E^DCB^A	Print
End	+*	5E^DCB^A+	Pop Until '('
End	Empty	5E^DCB^A+*+	Pop Every element

PROGRAM CODE:

```
#define SIZE 50 /* Size of Stack */

#include <ctype.h>

#include

<stdio.h> char

s[SIZE];

int top = -1; /* Global declarations */
```

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

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

SAMPLE OUTPUT 1:

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

SAMPLE OUTPUT 2:

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

PROGRAM - 05

A) 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.

ABOUT THE EXPERIMENT:

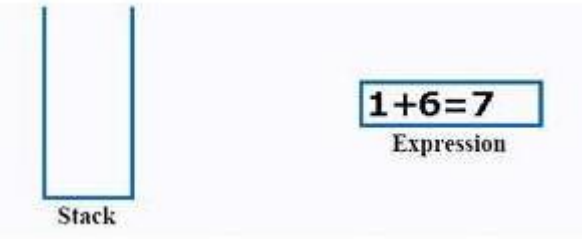
a. Evaluation of Suffix expression with single digit operands and operators: +, -, *, /, %, ^
Postfix/Suffix Expression: Operators are written after their operands. Ex: XY+ In normal algebra we use the infix notation like a+b*c. The corresponding postfix notation is abc*+

Example: Postfix String: 123*+4- Initially the Stack is empty. Now, the first three characters scanned are 1,2 and 3, which are operands. Thus they will be pushed into the stack in that order.

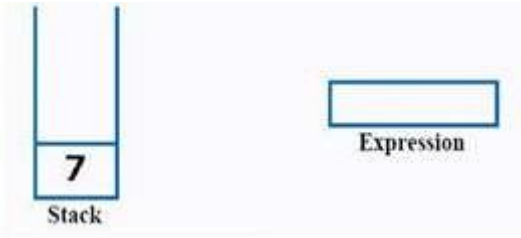
Next character scanned is "*", which is an operator. Thus, we pop the top two elements from the stack and perform the "*" operation with the two operands. The second operand will be the first element that is popped.

The value of the expression(2*3) that has been evaluated(6) is pushed into the stack.

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



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



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

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

The value of the expression (7-4) that has been evaluated(3) is pushed into the stack.

Now, since all the characters are scanned, the remaining element in the stack (there will be only one element in the stack) will be returned. End result: Postfix String:123*+4- Result: 3

PROGRAM CODE:

```
#include <stdio.h>
 #include <conio.h>
 #include <math.h>
#define MAX 20
struct stack
   {

    int top;

    float str[MAX];

    }s;//stack

   char

   postfix[MAX];//postfix

   void push(float);

   float pop();

   int isoperand(char);
  float operate(float,float,char);

 int main()
   {

   int i=0;
    printf("Enter Expression:");
    scanf("%s",postfix);
   float ans,op1,op2;

   while(postfix[i]!='\0')

   {
if(isoperand(postfix[i])) {
push(postfix[i]-48);  else
   {

   op1=pop();

   op2=pop();

   ans=operate(op1,op2,postfix[i]);

   push(ans);

   printf("%f %c %f = %f\n",op2,postfix[i],op1,ans);
   }i++;
   }
  printf("%f",s.str[s.top]);
  getch();
   }

   int isoperand(char x)

   {

   if(x>='0' && x<='9')
```

```
    return 1;

    else
    return 0;

    }

    void push(float x)

    {

    if(s.top==MAX-1)
      printf("Stack is full\nStack overflow\n");
else
    {

    s.top++;

    s.str[s.top]=x;

    }

    }

    float pop()

    {

    if(s.top==-1)

    {
   printf("Stack is emplty\nSTACK UNDERFLOW\n");
   getch();
    }

    else
    {

    s.top--;

    return s.str[s.top+1];

    }

    }

    float operate(float op1,float op2,char a)

    {

    switch(a)

    {

    case '+' : return op2+op1;

    case '-' : return op2-op1;

    case '*' : return op2*op1;

    case '/' : return op2/op1;

    case '^' : return pow(op2,op1);
```

```
}
}
```

SAMPLE OUTPUT 1:

```
Enter Expression:123*+4-
2.000000 * 3.000000 =
6.000000
1.000000 + 6.000000 = 7.000000
7.000000 - 4.000000 = 3.000000
3.000000
End Result: 3
```

SAMPLE OUTPUT 2:

```
Insert a postfix notation :: 22^32*+ Result :: 10
```

SAMPLE OUTPUT 3:

```
Insert a postfix notation :: 23+ Result :: 5
```

B) Towers of Hanoi

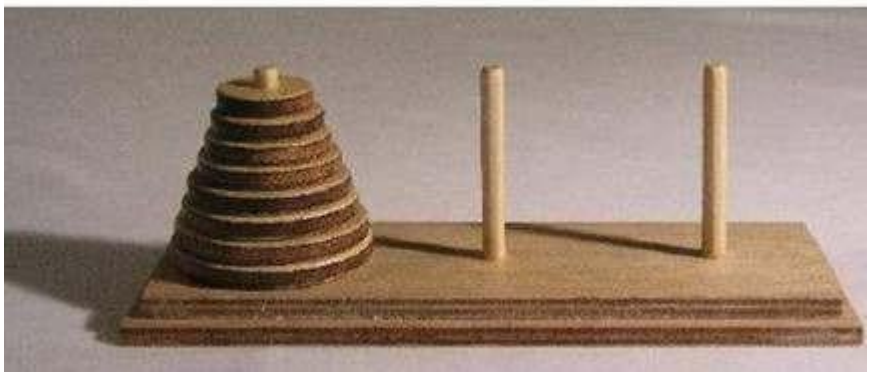
Solving Tower of Hanoi problem with n disks. The Tower of Hanoi is a mathematical game or puzzle. It consists of three rods, and a number of disks of different sizes which can slide onto any rod. The puzzle starts with the disks in a neat stack in ascending order of size on one rod, the smallest at the top, thus making a conical shape.

The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules:

• Only one disk can be moved at a time.

• Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack i.e. a disk can only be moved if it is the uppermost disk on a stack.

• No disk may be placed on top of a smaller disk. With three disks, the puzzle can be solved in seven moves. The minimum number of moves required to solve a Tower of Hanoi puzzle is 2 n - 1, where n is the number of disks.



PROGRAM CODE:

```
#include <stdio.h>
#include <conio.h>
void tower(int n, int source, int temp,int destination)

{
if(n == 0)
return;
tower(n-1, source, destination, temp);
printf("\nMove disc %d from %c to %c", n, source,
destination); tower(n-1, temp, source, destination);
}
void main()
{
int n;
printf("\nEnter the number of discs: \n");
scanf("%d", &n);
tower(n, 'A', 'B', 'C');
printf("\n\nTotal Number of moves are: %d", (int)pow(2,n)-1);
getch();
}
```

SAMPLE OUTPUT 1:

Enter the number of discs: 3

Move disc 1 from A to C

Move disc 2 from A to B

Move disc 1 from C to B

Move disc 3 from A to C

Move disc 1 from B to A

Move disc 2 from B to C

Move disc 1 from A to C

Total Number of moves are: 7

PROGRAM - 06

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**

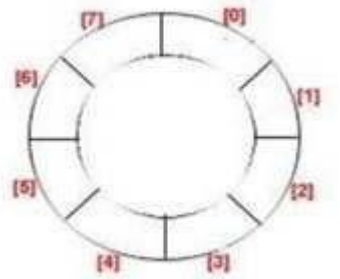
c. **Demonstrate Overflow and Underflow situations on Circular QUEUE**

d. **Display the status of Circular QUEUE e. Exit Support the program with appropriate functions for each of the above operations.**

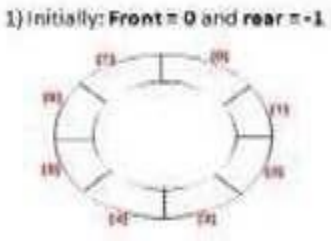
ABOUT THE EXPERIMENT:

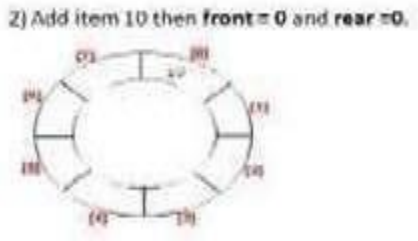
Circular queue is a linear data structure. It follows FIFO principle. In circular queue the last node is connected back to the first node to make a circle. Circular linked list fallow the First In First Out principle. Elements are added at the rear end and the elements are deleted at front end of the queue. The queue is considered as a circular queue when the positions 0 and MAX 1 are adjacent. Any position before front is also after rear.

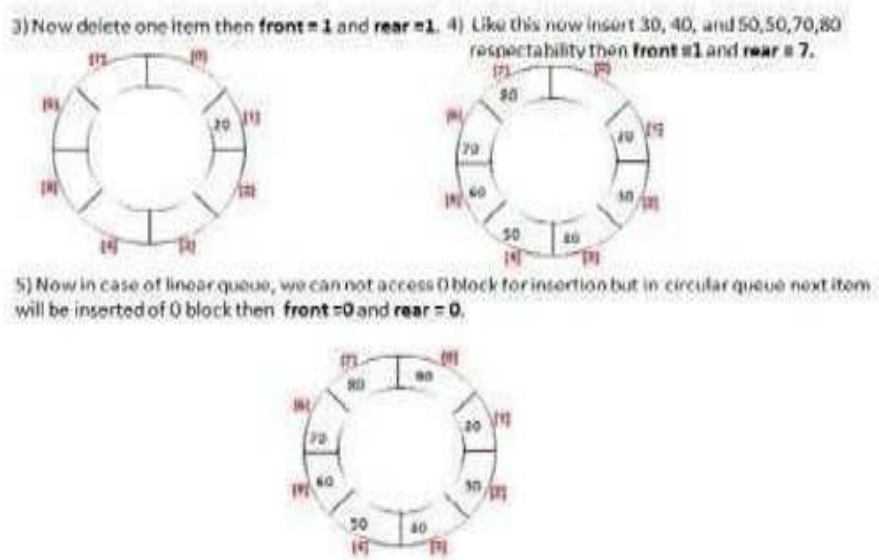
A circular queue looks like



Consider the example with Circular Queue implementation:







PROGRAM CODE:

```
#include <stdio.h>
#include <conio.h>
#define SIZE 5
   int CQ[SIZE];
   int front=-1;
   int rear=-1,
   ch;
   int IsCQ_Full();
   int IsCQ_Empty();
   void CQ_Insert(int );
   void CQ_Delet();
   void CQ_Display();
   void main()
   {
   printf("1.Insert\n2.Delete\n3.Display\n4.Exit\n
   "); while(1)
   {
   int ele;
   printf("Enter your choice\n");
   scanf("%d",&ch);
   switch(ch)
   {
   case 1: if(IsCQ_Full())
```

```
printf("Circular Queu

Overflow\n"); else

{

printf("Enter the element to be inserted\n");

scanf("%d",&ele); CQ_Insert(ele);

}

break;
case 2: if(IsCQ_Empty())
printf("Circular Queue Underflow\n"); else
CQ_Delet();

break;

case 3: if(IsCQ_Empty())
printf("Circular Queue Underflow\n"); else
CQ_Display();

break;

case 4: exit(0);

}
}

}

void CQ_Insert(int item)

{

if(front==-1)

front++;

rear = (rear+1)%SIZE;

CQ[rear] =item;

}

void CQ_Delet()

{
int item; item=CQ[front];
printf("Deleted element is: %d",item);
front = (front+1)%SIZE;
}

void CQ_Display()

{
int i;
if(front==-1)
printf("Circular Queue is Empty\n");
else
{
printf("Elements of the circular queue are..\n");
```

```
for(i=front;i!=rear; i=(i+1)%SIZE);
    {
    printf("%d\t",CQ[i]);
    }
    printf("%d\n",CQ[i]);
    }
    }
   int IsCQ_Full()
    {
if(front ==(rear+1)%SIZE) return 1;
    }
    int IsCQ_Empty()
    {
    if(front == -1)
    return 1;
    else if(front == rear)
    {
printf("Deleted element is: %d",CQ[front]);
front=-1;
    return 1;
    }
    return 0;
    }
```

SAMPLE OUTPUT 1:

```
    Circular Queue operations
    1.insert
    2. delete
    3.display
    4.exit
    Enter your choice:1
    Enter element to be insert:10
    Enter your choice:1
    Enter element to be insert:20
    Enter your choice:1
    Enter element to be insert:30
```

Enter your choice:3 10 20 30 rear is at 30 front is at 10 Enter

your choice:2 Deleted element is:10

Enter your choice:3 20 30 rear is at 30 front is at 20

Enter your choice:4

Exit

SAMPLE OUTPUT 2:

Circular Queue operations 1.insert 2.delete 3.display 4.exit

Enter your choice:1

Enter element to be insert:1000

Enter your choice:1

Enter element to be insert:2000

Enter your choice:1

Enter element to be insert:3000

Enter your choice:3 1000 2000 3000 rear is at 3000 front is at 1000

Enter your choice:2

Deleted element is:1000

Enter your choice:3 2000 3000 rear is at 3000 front is at 2000

Enter your choice:4

Exit

PROGRAM - 07

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

ABOUT THE EXPERIMENT:

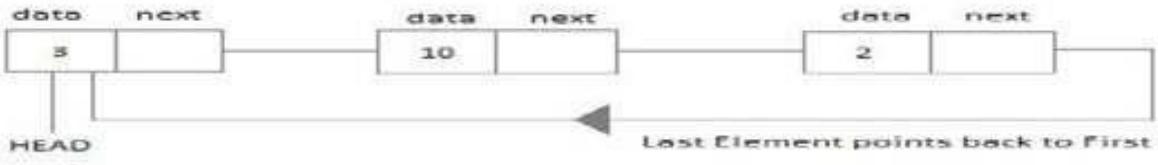
Linked List is a linear data structure and it is very common data structure which consists of group of nodes in a sequence which is divided in two parts. Each node consists of its own data and the address of the next node and forms a chain. Linked Lists are used to create trees and graphs.

- They are a dynamic in nature which allocates the memory when required.
- Insertion and deletion operations can be easily implemented.
- Stacks and queues can be easily executed.
- Linked List reduces the access time.
- Linked lists are used to implement stacks, queues, graphs, etc.
- Linked lists let you insert elements at the beginning and end of the list.
- In Linked Lists we don‟t need to know the size in advance.

Types of Linked List: Singly Linked List: Singly linked lists contain nodes which have a data part as well as an address part i.e. next, which points to the next node in sequence of nodes. The operations we can perform on singly linked lists are insertion, deletion and traversal.

Doubly Linked List: In a doubly linked list, each node contains two links the first link points to the previous node and the next link points to the next node in the sequence.

Circular Linked List: In the circular linked list the last node of the list contains the address of the first node and forms a circular chain.



PROGRAM CODE:

```
#include<stdio.>

#include<stdlib.>

#include<string.>

typedef struct

{

int usn;
 char name[20]; char branch[20]; int semester; char phone[20];
}STUDENT;

struct node

{

int usn;

char name[20];

char

branch[20]; int

semester;  char

phone[20];

struct node
```

```
   *link;

   };

   typedef struct

   node*NODE; NODE

   getnode()

   {

   NODE x;
x=(NODE)malloc(sizeof(struct node)); if(x==NULL)
   {
printf("out of memory\n"); exit(0);
   }


   return x;
   }

   NODE insert_front(STUDENT item,NODE first)

   {
NODE temp; temp=getnode(); temp>usn=item.usn;
strcpy(temp->name,item.name);
strcpy(temp>branch,item.branch);
temp->semester=item.semester;
strcpy(temp>phone,item.phone);
temp>link=NULL; if(first==NULL)
   return temp;

   temp>link=firs;

   return temp;

   }

   NODE insert_rear(STUDENT item,NODE first)

   {
NODE temp,cur; temp=getnode(); temp->usn=item.usn;
strcpy(temp->name,item.name); strcpy(temp->branch,item.branch);
temp->semester=item.semester;
strcpy(temp->phone,item.phone); temp->link=NULL; if(first==NULL)
return temp;
cur=first;
   while(cur->link!=NULL)


   {

   cur=cur->link;

   }

   cur->link=temp;

   return first;

   }

   NODE delete_front(NODE first)
```

```
    {
    NODE temp;
    if(first==NULL)
    {
    printf("student list is empty\n");
    return NULL;
    }
   temp=first; temp=temp->link;
printf("delete student record:USN=%d\n",first->usn); free(first);
    return temp;
    }
    NODE delete_rear(NODE first)
    {
    NODE cur,prev;
    if(first==NULL)
    {
printf("student list is empty cannot delete\n"); return first;
    }
    if(first->link==NULL)
    {
    printf("delete student record:USN=%d\n",first->usn);

return NULL;
}

prev=NULL;
cur=first;
    while(cur->link!=NULL)
    {
    prev=cur;
cur=cur->link;
    }
printf("delete student record:USN=%d\n",cur->usn); free(cur);
prev->link=NULL; return first;
    }
    void display(NODE first)
    {
    NODE
```

```
cur; int
count=0;
if(first==NULL)
{
printf("student list is empty\n");
return;
}
cur=first;
while(cur!=NULL)
{
printf("%d\t%s\t%s\t%d\t%s\t\n",cur->usn,cur->name,cur->branch,cur->semester,cur->phone);
cur=cur->link;
count++;
}

printf("numbrt of students=%d\n",count);
}
void main()
{
NODE first; int choice;
STUDENT
item;
first=NULL;
for(;;)
{
printf("1.insert_front\n2.insert_rear\n3.delete_front\n4.delete_rear\n5.display\n6.exit\n";

printf("Enter the choice\n");
scanf("%d",&choice);
switch(choice)
{
case 1:
printf("USN:\n);
scanf("%d",&item.usn);
printf("name :\n");
scanf("%s",item.name);
```

```
    printf("branch :\n");
    scanf("%s",item.branch);
    printf("semester:\n");
    scanf("%d",&item.semester);
    printf("phone :\n");
    scanf("%s",item.phone);
    first=insert_front(item,first);
    break;
    case 2:
    printf("USN:\n);
    scanf("%d",&item.usn);
    printf("name :\n");
    scanf("%s",item.name);
    printf("branch :\n");
    scanf("%s",item.branch);
    printf("semester:\n");
    scanf("%d",&item.semester);
    printf("phone :\n");
    scanf("%s",item.phone);
    first=insert_rear(item,first);
    break;
    case 3:
    first=delete_front(first);
    break;
    case 4:
    first=delete_rear(first);
    break;
   case 5: display(first); break;
default:
    exit(0);
    }
    }
    }
```

SAMPLE OUTPUT 1:

-

– ----------MENU----------

1 – create a SLL of n emp

2 - Display from beginning

3 - Insert at end

4 - delete at end

5 - Insert at beg

6 - delete at beg

7 – exit

Enter choice : 1

Enter no of students : 2

Enter usn,name, branch, sem, phno of student : 007 vijay ISE 3 121 Enter

usn,name, branch, sem, phno of student : 100 yashas ISE 3 911 Enter

choice : 2

Linked list elements from begining : 100

yashas ISE 3 911 007 vijay ISE 3 121 No

of students = 2

Enter choice : 3

Enter usn,name, branch, sem, phno of student : 001 raj ISE 3 111

Enter choice : 2

Linked list elements from begining : 100 yashas ISE 3 911 007 vijay ISE 3 121 001 raj ISE 3 111

No of students = 3

Enter choice : 4 001 raj ISE 3 111

Enter choice : 2

Linked list elements from begining : 100 yashas ISE 3 911 007 vijay ISE 3 121 No

of students = 2

Enter choice : 5

Enter usn,name, branch, sem, phno of student : 003 harsh cse 3 111

Enter choice : 2

Linked list elements from begining : 003 harsh cse 3 111 100 yashas ISE 3 911 007 vijay

ISE 3 121

No of students = 3

Enter choice : 6

003 harsh cse 3 111 Enter choice : 2

Linked list elements from begining : 100 yashas ISE 3 911 007 vijay ISE 3 121 No of students = 2

Enter choice : 7

Exit

SAMPLE OUTPUT 2:

– ----------MENU----------

1 – create a SLL of n emp

2 - Display from beginning

3 - Insert at end

4 - delete at end

5 - Insert at beg

6 - delete at beg

7 – exit

Enter choice : 1

Enter no of students : 1

Enter usn,name, branch, sem, phno of student : 009 suhas ISE 8 9854125422

Enter choice : 2 Linked list elements from begining : 009 suhas ISE 8 9854125422

No of students = 1

Enter choice : 3 Enter usn,name, branch, sem, phno of student : 001 raj ISE 3 111

Enter choice : 2

Linked list elements from begining : 009 suhas ISE 8 9854125422 001 raj ISE 3 111

No of students = 2

Enter choice : 4 001 raj ISE 3 111 Enter choice : 2

Linked list elements from begining : 009 suhas ISE 8 9854125422

No of students = 1

Enter choice : 5

Enter usn,name, branch, sem, phno of student : 009 suhas ISE 8 9854125422

003 harsh ise 3 111

Enter choice : 2

Linked list elements from begining : 009 suhas ISE 8 9854125422 003 harsh ise 3 111

No of students = 2

Enter choice : 6

003 harsh cse 3 111

Enter choice : 2

Linked list elements from begining : 003 harsh cse 3 111

No of students = 1

Enter choice : 7

PROGRAM - 08

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

ABOUT THE EXPERIMENT:

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

The beginning and ending nodes' previous and next links, respectively, point to some kind of terminator, typically a sentinel node or null, to facilitate traversal of the list. If there is only one sentinel node, then the list is circularly linked via the sentinel node. It can be conceptualized as two singly linked lists formed from the same data items, but in opposite sequential orders. A doubly linked list whose nodes contain three fields: an integer value, the link to the next node, and the link to the previous node.

The two node links allow traversal of the list in either direction. While adding or removing a node in a doubly linked list requires changing more links than the same operations on a singly linked list, the operations are simpler and potentially more efficient (for nodes other than first nodes) because there is no need to keep track of the previous node during traversal or no need to traverse the list to find the previous node, so that its link can be modified.

PROGRAM CODE:

```
#include <stdio.h>
 #include <stdlib.h>
 #include <string.h>
struct Enode
   {
   char ssn[15];
   char
   name[20];
   char dept[5];
   char
   designation[10];
```

```
    int salary;
long long int phno; struct Enode *left; struct Enode *right;
    }*head=NULL;
    struct Enode *tail,*temp1,*temp2;

void create(char [],char [],char [],char [],int ,long long int);
void ins_beg(char [],char [],char [],char [],int ,long long int);
void ins_end(char [],char [],char [],char [],int ,long long int);
    void del_beg();
    void del_end();
    void display();
    int count=0;
    void main()
    {
    int choice;
    char s[15],n[20],dpt[5],des[10];
    int sal;
    long long int p;
    printf("1.Create\n2.Display\n3.Insert at beginning\n4.Insert at End\n5.Delete at
    beginning\n6.Delete at End\n7.Exit\n");
    while(1)
    {
    printf("\nEnter your choice\n");
    scanf("%d",&choice);
    switch(choice)
    {
    case 1:
printf("Enter the required data(Emp no,Name,Dept,Desig,sal,phone\n");
scanf("%s%s%s%s%d%lld",s,n,dpt,des,&sal,&p); create(s,n,dpt,des,sal,p);
    break;
    case
    2:
    display();
    break;
    case 3:
    printf("Enter the required data (Emp no,Name,Dept,Desig,sal,phone\n");
    scanf("%s%s%s%s%d%lld",s,n,dpt,des,&sal,&p);
```

```
   ins_beg(s,n,dpt,des,sal,p);
   break;
   case 4:
printf("Enter the required data(Emp no,Name,Dept,Desig,sal,phone\n");
scanf("%s%s%s%s%d%lld",s,n,dpt,des,&sal,&p); ins_end(s,n,dpt,des,sal,p);
break;
case 5:del_beg();
break; case 6:
   del_end()
   ; break;
   case 7:
   exit(0);
   }
   }
   }
   void create(char s[15],char n[20],char dpt[5],char des[10],int sal,long long int p)
   {
   if(head==NULL)
   {
   head=(struct Enode *)malloc(1*sizeof(struct
   Enode)); strcpy(head->ssn,s);
   strcpy(head->name,n);
   strcpy(head->dept,dpt);
   strcpy(head->designation,des);
   head->salary=sal;
   head->phno=p;
   head->left=NULL;
   head->right=NULL;
   tail=head;
   }
   else
   {
temp1=(struct Enode *)malloc(1*sizeof(struct Enode)); strcpy(temp1->ssn,s);
   strcpy(temp1->name,n);
   strcpy(temp1->dept,dpt);
   strcpy(temp1->designation,des);
   temp1->salary=sal;
```

```
temp1->phno=p;
tail->right=temp1;
temp1->right=NULL;
temp1->left=tail;
tail=temp1;
}
}
void display()
{
temp1=head;
printf("Employee Details \n");
while(temp1!=NULL)
{
printf(" \n");
printf("%s\n%s\n%s\n%s\n%d\n%lld\n",temp1->ssn,temp1->name,temp1->dept,temp1->designation,temp1->salary,temp1->phno); printf(" "); temp1=temp1->right;
}
}
void ins_beg(char s[15],char n[20],char dpt[5],char des[10],int sal,long long int p)
{
temp1=(struct Enode *)malloc(1*sizeof(struct
Enode)); strcpy(temp1->ssn,s);
strcpy(temp1->name,n);
strcpy(temp1->dept,dpt);
strcpy(temp1->designation,des);
temp1->salary=sal;
temp1->phno=p;
temp1->right=head;
head->left=temp1;
head=temp1;
temp1->left=NULL;
}
void ins_end(char s[15],char n[20],char dpt[5],char des[10],int sal,long long int p)
{
temp1=(struct Enode *)malloc(1*sizeof(struct Enode));
strcpy(temp1->ssn,s);
```

```
strcpy(temp1->name,n);
strcpy(temp1->dept,dpt);
strcpy(temp1->designation,des);
temp1->salary=sal;
temp1->phno=p;
tail->right=temp1;
temp1->left=tail;
temp1->right=NULL;
tail=temp1;
}
void del_beg()
{
temp1=head->right;
free(head);
head=temp1;
head->left=NULL;
}
void del_end()
{
temp1=tail->left;
free(tail);
tail=temp1;
tail->right=NULL;
}
```

SAMPLE OUTPUT 1:

```
----------MENU----------
1.Create
2.Display
3. Insert at beginning
4. Insert at End
```

5. Delete at beginning

6. Delete at End

7. Exit

Enter choice : 1 Enter no of employees : 2

Enter ssn,name,department, designation, salary and phno of employee : 1 RAJ SALES MANAGER 15000 911 Enter ssn,name,department, designation, salary and phno of employee : 2 RAVI HR ASST 10000 123

Enter choice : 2

Linked list elements from begining : 1 RAJ SALES MANAGER 15000.000000 911 2 RAVI HR ASST 10000.000000 123 No of employees = 2

Enter choice : 3

Enter ssn,name,department, designation, salary and phno of employee : 3 RAM MARKET MANAGER 50000 111 Enter choice : 2 Linked list elements from begining : 1 RAJ SALES MANAGER 15000.000000 911 2 RAVI HR ASST 10000.000000 123 3 RAM MARKET MANAGER 50000.000000 111 No of employees = 3

Enter choice : 4

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

Enter choice : 5

Enter ssn,name,department, designation, salary and phno of employee : 0 ALEX EXE TRAINEE 2000 133 Enter choice : 2 Linked list elements from begining : 0 ALEX EXE TRAINEE 2000.000000 133 1 RAJ SALES MANAGER 15000.000000 911 2 RAVI HR ASST 10000.000000 123 No of employees = 3

Enter choice : 6

0 ALEX EXE TRAINEE 2000.000000 133 Enter choice : 2 Linked list elements from begining : 1 RAJ SALES MANAGER 15000.000000 911 2 RAVI HR ASST 10000.000000 123 No of employees = 2

Enter choice : 7

Exit

SAMPLE OUTPUT 2:

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

1.Create

2.Display

3. Insert at beginning

4. Insert at End

5. Delete at beginning

6. Delete at End

7. Exit

- -

Enter choice : 1

Enter no of employees : 1

Enter ssn,name,department, designation, salary and phno of employee : 1 RAJ SALES MANAGER 15000 911

Enter choice : 2

Linked list elements from begining :

1 RAJ SALES MANAGER 15000.000000 911

No of employees = 1

Enter choice : 3

Enter ssn,name,department, designation, salary and phno of employee : 3 RAM MARKET MANAGER 50000 111

Enter choice : 2

Linked list elements from begining : 1

RAJ SALES MANAGER 15000.000000 911 2 RAM MARKET MANAGER 50000.000000 111

No of employees = 2

Enter choice : 4

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

Enter choice : 5

Enter ssn,name,department, designation, salary and phno of employee : 0 ALEX EXE TRAINEE 2000 133

Enter choice : 2

Linked list elements from begining : 3

ALEX EXE TRAINEE 2000.000000 133 4 RAJ SALES MANAGER 15000.000000 911 5 RAVI HR ASST 10000.000000 123

No of employees = 3

Enter choice : 6

0 ALEX EXE TRAINEE 2000.000000 133

Enter choice : 2

Linked list elements from begining : 3

RAJ SALES MANAGER 15000.000000 911 4 RAVI HR ASST 10000.000000 123 No of employees = 2

Enter choice : 7 Exit

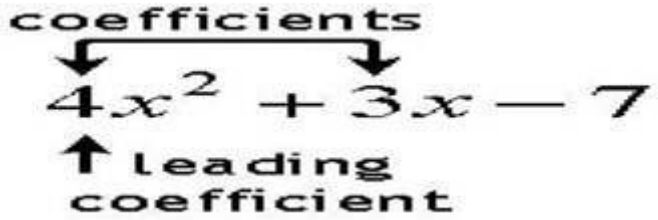
PROGRAM - 09

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 2 y 2 z-4yz 5 +3x 3 yz+2xy 5 z-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

ABOUT THE EXPERIMENT:

Circular Linked List: In the circular linked list the last node of the list contains the address of the first node and forms a circular chain. Polynomial: A polynomial equation is an equation that can be written in the form. ax n + bx n-1 + . . . + rx + s = 0, where a, b, . . . , r and s are constants.

We call the largest exponent of x appearing in a non-zero term of a polynomial the degree of that polynomial. As with polynomials with one variable, you must pay attention to the rules of exponents and the order of operations so that you correctly evaluate an expression with two or more variables. Evaluate x 2 + 3y 3 for x = 7 and y = −2. Substitute the given values for x and y. Evaluate4x 2 y – 2xy 2 + x – 7 for x = 3 and y = −1. When a term contains both a number and a variable part, the number part is called the "coefficient". The coefficient on the leading term is called the "leading" coefficient



In the above example, the coefficient of the leading term is 4; the coefficient of the second term is 3; the constant term doesn't have a coefficient. Here are the steps required for Evaluating Polynomial Functions: Step 1: Replace each x in the expression with the given value. Step 2: Use the order of operation to simplify the expression.example 1

$$\text{Given } f(x) = -2x^2 + 5x - 7, \text{find } f(3).$$

Step 1: Replace each x in the expression with the given value. In this case, we replace each x with 3.

$$f(3) = -2(3)^2 + 5(3) - 7$$

Step 2: Use the order of operation to simplify the expression.

$$f(3) = -2(9) + 5(3) - 7$$
$$f(3) = -18 + 15 - 7$$
$$f(3) = -10$$

Here are the steps required for addition of two polynomials.

Step 1

• Arrange the Polynomial in standard form

• Standard form of a polynomial and each of the following terms just means that the term with highest degree is first

Step 2

• Arrange the like terms in columns and add the like terms

Example 1: Let's find the sum of the following two polynomials (3y 5 − 2y + y 4 + 2y 3 + 5) and (2y 5 + y 3 + 2+ 7)

---

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

2) Arrange in columns of like terms and then add

$$\begin{array}{r} 3y^5 + y^4 + 2y^3 - 2y + 5 \\ 2y^5 \quad\quad + 3y^3 + 7y + 2 \\ \hline 5y^5 + y^4 + 5y^3 + 5y + 7 \end{array}$$

PROGRAM CODE:

```
#include  <stdio.h>
#include <conio.h>
#include <stdlib.h>
#include  <math.h>
struct node
{
int coeff; int expo;
struct node *ptr;
};
struct node *head1,*head2,*head3,
*temp,*temp1,*temp2,*temp3,*list1,*list2,*list3; struct node
*dummy1,*dummy2;
```

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

```
case 3:
display(); break;
 case 4:
   add_poly();
   break;
   case 5:
   printf("Enter the value for x\n");
   scanf("%d",&x);
   eval_poly(x);
   break;
   case 6:exit(0);
   }
   }
   }
   void create_poly1(int c, int e)
   {
   dummy1=(struct node*)malloc(1*sizeof(struct node));
   dummy1->coeff=0;
   dummy1->expo=0;
   dummy1->ptr=list1;
   if(list1==NULL)
   {
   list1->coeff=c;
   list1->expo=e;
   list1->ptr=list1; head1=list1;

   head1->ptr=dummy1;
   }
   else
   {
temp=(struct node*)malloc(1*sizeof(struct node)); temp->coeff=c;
temp->expo=e; head1->ptr=temp; temp->ptr=dummy1; head1=temp;
   }
   }
   void create_poly2(int c, int e)
   {
   dummy2=(struct node*)malloc(1*sizeof(struct
```

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

   temp->expo=e;
   head2->ptr=temp;
   temp-
   >ptr=dummy2;
   head2=temp;
   }
   }
   void add_poly()
   {
   temp1=list1;
   temp2=list2;
   while((temp1!=dummy1)&&(temp2!=dummy2))
   {
   temp=(struct node*)malloc(1*sizeof(struct node));
   if(list3==NULL)
   {
   list3=temp;
   head3=list3;
   }
   if(temp1->expo==temp2->expo)
```

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

    else if(temp1->expo>temp2->expo)

    {

    temp->coeff=temp1->coeff;
   temp->expo=temp1->expo;
  temp->ptr=list3;
 head3->ptr=temp; head3=temp;
 temp1=temp1->ptr;
    }

    else

    {

    temp->coeff=temp2->coeff; temp->expo=temp2->expo; temp->ptr=list3;

    head3->ptr=temp; head3=temp; temp2=temp2->ptr;
    }

    }

    if(temp1==dummy1)

    {

    while(temp2!=dummy2)

    {
temp=(struct node*)malloc(1*sizeof(struct node));
temp->coeff=temp2->coeff;
    temp->expo=temp2->expo;

    temp->ptr=list3;

    head3->ptr=temp;

    head3=temp;

    temp2=temp2->ptr;

    }

    }

    if(temp2==dummy2)

    {
```

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

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

SAMPLE OUTPUT 1:

```
    ----------<< MENU >>----------
    Polynomial Operations :
    1.Add
    2.Evaluate
    3.Exit
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    Enter your choice==>1
    Enter no of terms of polynomial==>3
     Enter coef & expo==>
    4
```

```
3
Enter coef & expo==>
2
2
Enter coef & expo==>
 5
1
The polynomial is==>5x^(1) + 2x^(2) + 4x^(3)
Enter no of terms of polynomial==>3
Enter coef & expo==>
4
1
Enter coef & expo==>
3
2
Enter coef & expo==>
5
3
The polynomial is==>4x^(1) + 3x^(2) + 5x^(3)
Addition of polynomial==> The polynomial is==>9x^(1) + 5x^(2) + 9x^(3)
Enter your choice==>2
Enter no of terms of polynomial==>3
Enter coef & expo==> 1
Enter coef & expo==>
4
2
Enter coef & expo==>
5
```

4

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

Enter the value of x=2

Value of polynomial=102

Enter your choice==>3

exit

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

ABOUT THE EXPERIMENT:

A binary search tree (BST) is a tree in which all nodes follows the below mentioned properties • The left sub-tree of a node has key less than or equal to its parent node's key. • The right sub-tree of a node has key greater than or equal to its parent node's key. Thus, a

binary search tree (BST) divides all its sub-trees into two segments; left sub-tree and right sub-tree and can be defined as left_subtree (keys) ≤ node (key) ≤ right_subtree (keys)

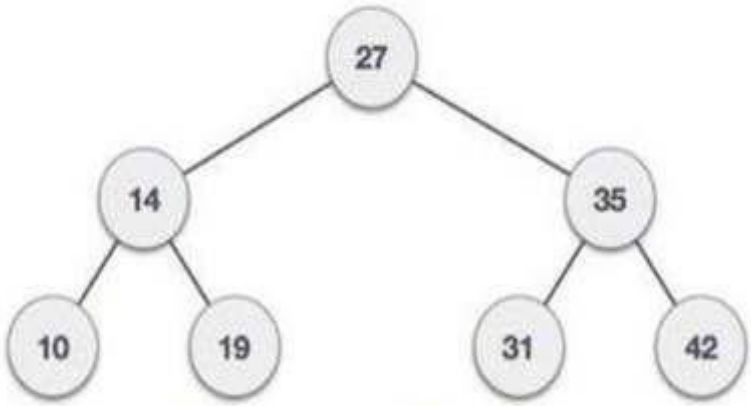


Fig: An example of BST

Following are basic primary operations of a tree which are following.

• Search − search an element in a tree.

• Insert − insert an element in a tree. • Preorder Traversal − traverse a tree in a preorder manner.

- Inorder Traversal − traverse a tree in an inorder manner.
- Postorder Traversal − traverse a tree in a postorder manner.

Node definition: Define a node having some data, references to its left and right child nodes. struct node { 5. int data; struct node *leftChild; struct node *rightChild; };

PROGRAM CODE

```
#include  <stdio.h>
#include
<stdlib.h>      struct
BST
{
int data;
struct BST *left;
struct BST *right;
};
typedef struct BST NODE;
NODE *node;
NODE* createtree(NODE *node, int data)
{
if (node == NULL)
{
NODE *temp;
temp=
(NODE*)malloc(sizeof(NODE)); temp-
>data = data;
temp->left = temp->right = NULL;
return temp;
}
```

```
if (data < (node->data))
{
node->left = createtree(node->left, data);
}
else if (data > node->data)
{
node -> right = createtree(node->right, data);

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

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

```
{
if(node==NULL)
{
return NULL;
}
if(node->left)
return findMin(node->left);
else
return node;
}
NODE* del(NODE *node, int data)
{
NODE *temp;
if(node == NULL)
{
printf("\nElement not found");
}
else if(data < node->data)
{
node->left = del(node->left, data);
}
else if(data > node->data)
{
node->right = del(node->right, data);
}
else
{
/* Now We can delete this node and replace with either minimum element in the right sub
tree or maximum element in the left subtree */
```

```
if(node->right && node->left)
{
/* Here we will replace with minimum element in the right sub tree */
temp = findMin(node->right);
node -> data = temp->data;
/* As we replaced it with some other node, we have to delete that node */
node -> right = del(node->right, temp->data);
}
else
{
/* If there is only one or zero children then we can directly remove it from the tree and
connect its
parent to its child */
temp = node;
if(node->left == NULL)
node = node->right;
else if(node->right == NULL)
node = node->left;
free(temp); /* temp is longer required */
}
}
return node;
}
void main()
{
int data, ch, i, n;
NODE *root=NULL;
while (1)
{
```

```
printf("\n1.Insertion in Binary Search Tree");
printf("\n2.Search Element in Binary Search Tree");
printf("\n3.Delete Element in Binary Search Tree");
printf("\n4.Inorder\n5.Preorder\n6.Postorder\n7.Exit");
printf("\nEnter your choice: "); scanf("%d", &ch);
switch (ch)
{
case 1:
printf("\nEnter N value: " );
scanf("%d", &n);
printf("\nEnter the values to create BST like(6,9,5,2,8,15,24,14,7,8,5,2)\n");
for(i=0; i<n; i++)
{
scanf("%d", &data);
root=createtree(root, data);
}
break;
case 2:
printf("\nEnter the element to search: ");
scanf("%d", &data);
break;
case 3:
printf("\nEnter the element to delete: ");
scanf("%d", &data);
root=del(root,
data); break;
case 4:
printf("\nInorder Traversal: \n");
```

```
inorder(root);
break;
case 5:
printf("\nPreorder Traversal: \n");
preorder(root);
break;
case 6:
printf("\nPostorder Traversal: \n");
postorder(root);
break;
case 7:
exit(0);
default : printf("\nWrong option");
break;
}
}
}
```

SAMPLE OUTPUT 1:

```
Program For Binary Search Tree
1. Create
2. Search
3. Recursive Traversals
4. Exit
Enter your choice :1
Enter The Element 15
Want To enter More Elements?(1/0)1
Enter The Element 25
Want To enter More Elements?(1/0)1
```

Enter The Element 35

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

Enter The Element 45

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

Enter The Element 5

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

Enter The Element 7

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

Enter your choice :2

Enter Element to be searched :7

The 7 Element is Present Parent of node 7 is 5

1. Create

2. Search
3. Recursive Traversals

4.Exit

Enter your choice :2

Enter Element to be searched :88

The 88 Element is not Present

Enter your choice :3

The Inorder display : 5 7 15 25 35 45

The Preorder display : 15 5 7 25 35 45

The Postorder display : 7 5 45 35 25 15

Enter your choice :4

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

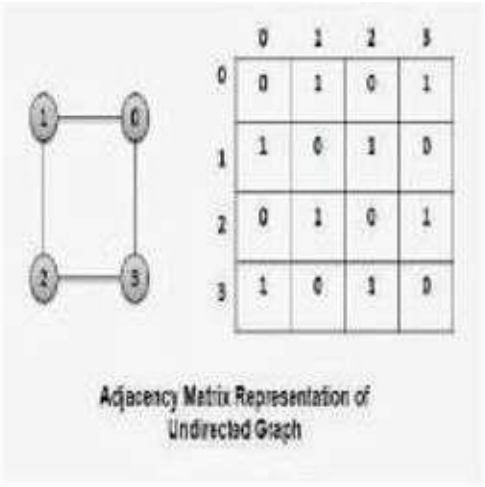
ABOUT THE EXPERIMENT:

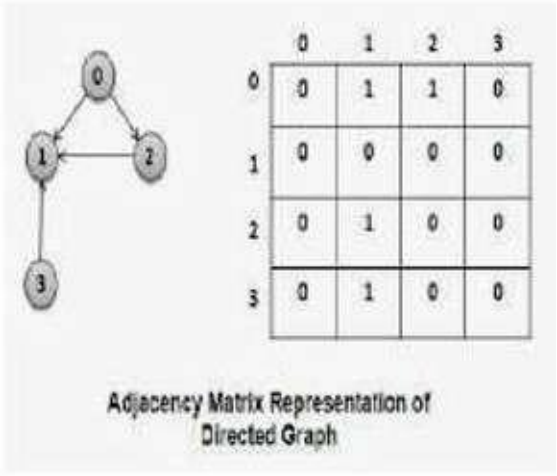
Adjacency Matrix In graph theory, computer science, an adjacency matrix is a square matrix used to represent a finite graph. The elements of the matrix indicate whether pairs of vertices are adjacent or not in the graph. In the special case of a finite simple graph, the adjacency matrix is a (0, 1)-matrix with zeros on its diagonal. A graph G = (V, E) where v= {0, 1, 2, . . .n-1} can be represented using two dimensional integer array of size n x n. a[20][20] can be used to store a graph with 20 vertices. a[i][j] = 1, indicates presence of edge between two vertices i and j. a[i][j] = 0, indicates absence of edge between two vertices i and j.

- A graph is represented using square matrix.

• Adjacency matrix of an undirected graph is always a symmetric matrix, i.e. an edge (i, j) implies the edge (j, i).

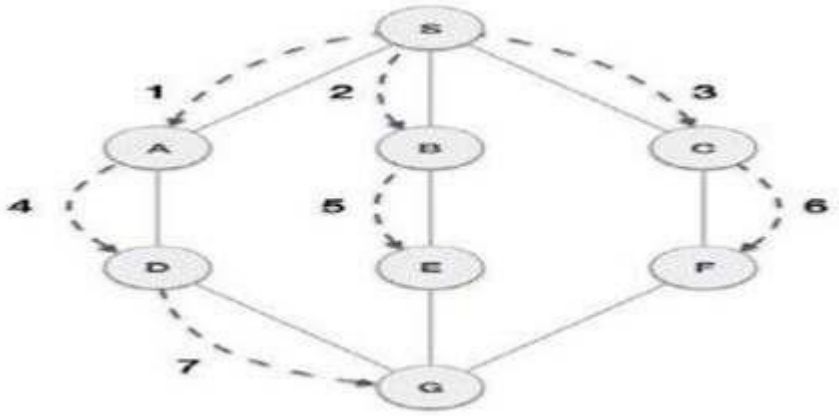
• Adjacency matrix of a directed graph is never symmetric, adj[i][j] = 1 indicates a directed edge from vertex i to vertex j. An example of adjacency matrix representation of an undirected and directed graph is given below:





BFS graph Breadth-first search (BFS) is an algorithm data structures. It starts at the tree root for traversing or searching tree or and explores the neighbor nodes first, before moving to the next level neighbors.

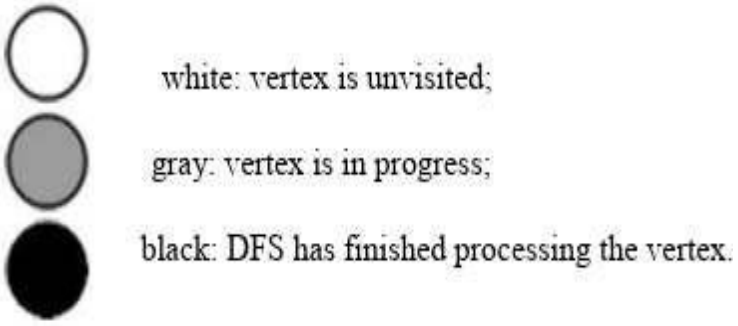
Breadth First Search algorithm(BFS) traverses a graph in a breadth wards motion and uses a queue to remember to get the next vertex to start a search when a dead end occurs in any iteration.



As in example given above, BFS algorithm traverses from A to B to E to F first then to C and G lastly to D. It employs following rules. 1.

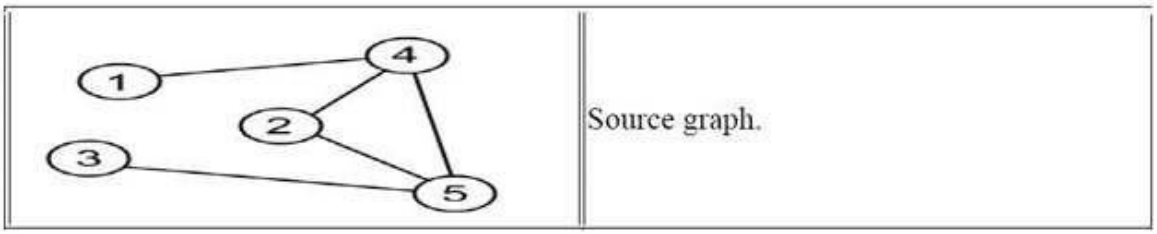
Rule 1 − Visit adjacent unvisited vertex. Mark it visited. Display it. Insert it in a queue. 2. Rule 2 − If no adjacent vertex found, remove the first vertex from queue. 3. Rule 3 − Repeat Rule 1 and Rule 2 until queue is empty. DFS Depth-first search (DFS) is an algorithm for traversing or searching tree or graph data structures. One starts at the root (selecting some arbitrary node as the root in the case of a graph) and explores as far as possible along each branch before backtracking.

Depth-first search, or DFS, is a way to traverse the graph. Initially it allows visiting vertices of the graph only, but there are hundreds of algorithms for graphs, which are based on DFS. Therefore, understanding the principles of depth-first search is quite important to move ahead into the graph theory. The principle of the algorithm is quite simple: to go forward (in depth) while there is such possibility, otherwise to backtrack. Algorithm In DFS, each vertex has three possible colors representing its state:



NB. For most algorithms Boolean classification unvisited / visited is quite enough, but we show general case here. Initially all vertices are white (unvisited). DFS starts in arbitrary vertex and runs as follows: 5.Mark vertex u as gray (visited). 6.For each edge (u, v), where u is white, run depth-first search for u recursively. 7.Mark vertex u as black and backtrack to

the parent. Example. Traverse a graph shown below, using DFS. Start from a vertex with number 1 .



PROGRAM CODE:

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

```
int i; reach[v]=1;
for(i=1;i<=n;i++)
{
if(a[v][i] && !reach[i])
{
printf("\n %d->%d",v,i);
count++;
dfs(i);
}
}
}
void main()
{
int v, choice;
printf("\n Enter the number of vertices:");
scanf("%d",&n);
for(i=1;i<=n;i++)
{
q[i]=0;
visited[i]=0;
}
for(i=1;i<=n-1;i++)
reach[i]=0;
printf("\n Enter graph data in matrix form:\n");
for(i=1;i<=n;i++)
for(j=1;j<=n;j++)
scanf("%d",&a[i][j]);
printf("1.BFS\n 2.DFS\n 3.Exit\n");
```

```
scanf("%d",&choice);
switch(choice)
{
case 1:
printf("\n Enter the starting vertex:");
scanf("%d",&v);
bfs(v);
if((v<1)||(v>n))
{
printf("\n Bfs is not possible");
}
else
{
printf("\n The nodes which are reachable from %d:\n",v);
for(i=1;i<=n;i++)
if(visited[i])
printf("%d\t",i);
}
break;
case 2:
dfs(1);
if(count==n-1)
printf("\n Graph is connected");
else
printf("\n Graph is not connected");
break;
case 3: exit(0);
}}
```

SAMPLE OUTPUT 1:

Enter the number of vertices:5

Enter graph data in matrix form: 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 0 0 1 0 0 0

1. BFS

2. DFS

3. Exit 2

1->2 2->3 3->4 2->5

Graph is connected

Enter the number of vertices:5

Enter graph data in matrix form: 0 1 0 1 0 1 0 1 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0

1. BFS

2. DFS

3. Exit 2

1->2

2->3

3->4

Graph is not connected

Enter the number of vertices:5

Enter graph data in matrix form: 0 1 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0

1. BFS

2. DFS

3. Exit 1

Enter the starting vertex:1

The nodes which are reachable from 1: 2 3 4Enter graph data in matrix form: 0 1 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0

1. BFS

2. DFS

3. Exit 1Enter the starting vertex:0 BFS is not possible

PROGRAM - 12

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.

PROGRAM CODE:

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

```
printf("\n Do you wish to continue ? (1/0) ");
scanf("%d",&ans);
}while(ans);
display(a);
}
int create(int num)
{
int key;
key=num%100;
return key;
}
void linear_prob(int a[MAX], int key, int num)
{
int flag, i, count=0;
flag=0;
if(a[key]== -1)
{
a[key] = num;
}
else
{
printf("\nCollision Detected...!!!\n");
i=0;
while(i<MAX)
{
if (a[i]!=-1)
count++;
i++;
}
```

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

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

SAMPLE OUTPUT 1:

collision handling by linear probing :

Enter the data1234

Do you wish to continue ? (1/0) 1 Enter the data2548

Do you wish to continue ? (1/0) 1 Enter the data3256

Do you wish to continue ? (1/0) 1 Enter the data1299

Do you wish to continue ? (1/0) 1 Enter the data1298

Do you wish to continue ? (1/0) 1 Enter the data1398

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

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

1. Display ALL
2. Filtered Display 2 the hash table is 0 1398 34 1234 48 2548 56 3256 98 1298 99 1299

Additional Open-Ended Experiment

Title:

Develop a Program in C to implement a Priority Queue using a linked list. Perform the following operations:
a) Insert an element into the priority queue (based on priority).
b) Delete the highest priority element from the queue.
c) Display the contents of the queue.

ABOUT THE EXPERIMENT:

A Priority Queue is a type of queue in which elements are served based on their priority rather than their order in the queue. The element with the highest priority is removed first.
We can use a linked list to maintain elements in sorted order of priority for easy insertion and deletion operations.

PROGRAM CODE:

```
#include <stdio.h>

#include <stdlib.h>


struct Node {

   int data;

   int priority;

   struct Node* next;

};


struct Node* front = NULL;
```

```
void insert(int data, int priority) {
    struct Node* temp = (struct Node*)malloc(sizeof(struct Node));
    temp->data = data;
    temp->priority = priority;
    temp->next = NULL;

    if (front == NULL || priority < front->priority) {
        temp->next = front;
        front = temp;
    } else {
        struct Node* ptr = front;
        while (ptr->next != NULL && ptr->next->priority <= priority) {
            ptr = ptr->next;
        }
        temp->next = ptr->next;
        ptr->next = temp;
    }
    printf("Inserted %d with priority %d\n", data, priority);
}

void delete() {
    if (front == NULL) {
        printf("Priority Queue is empty.\n");
        return;
    }
    struct Node* temp = front;
    printf("Deleted element: %d with priority %d\n", temp->data, temp->priority);
    front = front->next;
```

```
    free(temp);
}

void display() {
    if (front == NULL) {
        printf("Priority Queue is empty.\n");
        return;
    }
    struct Node* ptr = front;
    printf("Priority Queue: \n");
    while (ptr != NULL) {
        printf("Data: %d, Priority: %d\n", ptr->data, ptr->priority);
        ptr = ptr->next;
    }
}

int main() {
    int choice, data, priority;
    while (1) {
        printf("\n1. Insert\n2. Delete\n3. Display\n4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter data and priority: ");
                scanf("%d %d", &data, &priority);
                insert(data, priority);
```

```
            break;
        case 2:
            delete();
            break;
        case 3:
            display();
            break;
        case 4:
            exit(0);
        default:
            printf("Invalid choice!\n");
      }
   }
   return 0;
}
```

SAMPLE OUTPUT:

1. Insert

2. Delete

3. Display

4. Exit

Enter your choice: 1

Enter data and priority: 30 2

Inserted 30 with priority 2

Enter your choice: 1

Enter data and priority: 50 1

Inserted 50 with priority 1

Enter your choice: 3

Priority Queue:

Data: 50, Priority: 1

Data: 30, Priority: 2

Enter your choice: 2

Deleted element: 50 with priority 1

Enter your choice: 3

Priority Queue:

Data: 30, Priority: 2

VIVA QUESTIONS AND ANSWERS

1) What is data structure?

Data structures refers to the way data is organized and manipulated. It seeks to find ways to make data access more efficient. When dealing with data structure, we not only focus on one piece of data, but rather different set of data and how they can relate to one another in an organized manner.

2) Differentiate file structure from storage structure.

Basically, the key difference is the memory area that is being accessed. When dealing with the structure that resides the main memory of the computer system, this is referred to as storage structure. When dealing with an auxiliary structure, we refer to it as file structures.

3) When is a binary search best applied?

A binary search is an algorithm that is best applied to search a list when the elements are already in order or sorted. The list is search starting in the middle, such that if that middle value is not the target search key, it will check to see if it will continue the search on the lower half of the list or the higher half. The split and search will then continue in the same manner.

4) What is a linked list?

A linked list is a sequence of nodes in which each node is connected to the node following it. This forms a chain-like link of data storage.

5) How do you reference all the elements in a one-dimension array?

To do this, an indexed loop is used, such that the counter runs from 0 to the array size minus one. In this manner, we are able to reference all the elements in sequence by using the loop counter as the array subscript.

6) In what areas do data structures applied?

Data structures is important in almost every aspect where data is involved. In general, algorithms that involve efficient data structure is applied in the following areas: numerical analysis, operating system, A.I., compiler design, database management, graphics, and statistical analysis, to name a few.

7) What is LIFO?

LIFO is short for Last In First Out, and refers to how data is accessed, stored and retrieved. Using this scheme, data that was stored last , should be the one to be extracted first. This also means that in order to gain access to the first data, all the other data that was stored before this first data must first be retrieved and extracted.

8) What is a queue?

A queue is a data structures that can simulates a list or stream of data. In this structure, new elements are inserted at one end and existing elements are removed from the other end.

9) What are binary trees?

A binary tree is one type of data structure that has two nodes, a left node and a right node. In programming, binary trees are actually an extension of the linked list structures.

10) Which data structures is applied when dealing with a recursive function?

Recursion, which is basically a function that calls itself based on a terminating condition, makes use of the stack. Using LIFO, a call to a recursive function saves the return address so that it knows how to return to the calling function after the call terminates.

11) What is a stack?

A stack is a data structure in which only the top element can be accessed. As data is stored in the stack, each data is pushed downward, leaving the most recently added data on top.

12) Explain Binary Search Tree

A binary search tree stores data in such a way that they can be retrieved very efficiently. The left subtree contains nodes whose keys are less than the node's key value, while the right subtree contains nodes whose keys are greater than or equal to the node's key value. Moreover, both

subtrees are also binary search trees.

13) What are multidimensional arrays?

Multidimensional arrays make use of multiple indexes to store data. It is useful when storing data that cannot be represented using a single dimensional indexing, such as data representation in a board game, tables with data stored in more than one column.

14) Are linked lists considered linear or non-linear data structures?

It actually depends on where you intend to apply linked lists. If you based it on storage, a linked list is considered non-linear. On the other hand, if you based it on access strategies, then a linked list is considered linear.

15) How does dynamic memory allocation help in managing data?

Aside from being able to store simple structured data types, dynamic memory allocation can combine separately allocated structured blocks to form composite structures that expand and contract as needed.

16) What is FIFO?

FIFO is short for First-in, First-out, and is used to represent how data is accessed in a queue. Data has been inserted into the queue list the longest is the one that is removed first.

17) What is an ordered list?

An ordered list is a list in which each node's position in the list is determined by the value of its key component, so that the key values form an increasing sequence, as the list is traversed.

18) What is merge sort?

Merge sort takes a divide-and-conquer approach to sorting data. In a sequence of data, adjacent ones are merged and sorted to create bigger sorted lists. These sorted lists are then merged again to form an even bigger sorted list, which continuous until you have one single sorted list.

19) Differentiate NULL and VOID.

Null is actually a value, whereas Void is a data type identifier. A variable that is given a Null value simply indicates an empty value. Void is used to identify pointers as having no initial size.

20) What is the primary advantage of a linked list?

A linked list is a very ideal data structure because it can be modified easily. This means that modifying a linked list works regardless of how many elements are in the list.

21) What is the difference between a PUSH and a POP?

Pushing and popping applies to the way data is stored and retrieved in a stack. A push denotes data being added to it, meaning data is being "pushed" into the stack. On the other hand, a pop denotes data retrieval, and in particular refers to the topmost data being accessed.

22) What is a linear search?

A linear search refers to the way a target key is being searched in a sequential data structure. Using this method, each element in the list is checked and compared against the target key, and is repeated until found or if the end of the list has been reached.

23) How does variable declaration affect memory allocation?

The amount of memory to be allocated or reserved would depend on the data type of the variable being declared. For example, if a variable is declared to be of integer type, then 32 bits of memory storage will be reserved for that variable.

24) What is the advantage of the heap over a stack?

Basically, the heap is more flexible than the stack. That's because memory space for the heap can be dynamically allocated and de-allocated as needed. However, memory of the heap can at times be slower when compared to that stack.

25) What is a postfix expression?

A postfix expression is an expression in which each operator follows its operands. The advantage of this form is that there is no need to group sub-expressions in parentheses or to consider operator precedence.

**********##########**********