THE NEOTIA UNIVERSITY
COMPUTER SCIENCE & ENGINEERING
DATA STRUCTURES

LAB MANUAL

2nd year, Semester - III

THE NEOTIA UNIVERSITY

COMPUTER SCIENCE & ENGINEERING

Program Outcomes	
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
Program Specific Outcomes	
PSO1	**Professional Skills:** The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.
PSO2	**Problem-Solving Skills:** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.
PSO3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.

DATA STRUCTURES LAB SYLLABUS

Recommended Systems/Software Requirements:

Intel based desktop PC with minimum of 166 MHZ or faster processor with at least 64 MB RAM and 100MB free disk space. C compiler.

S. No.	List of Experiments
1	Write a C program that uses functions to perform the following: a) Create a singly linked list of integers. b) Delete a given integer from the above linked list. c) Display the contents of the above list after deletion.
2	Write a C program that uses functions to perform the following: a) Create a doubly linked list of integers. b) Delete a given integer from the above doubly linked list. c) Display the contents of the above list after deletion.
3	Write a C program that uses stack operations to convert a given infix expression into its postfix Equivalent, Implement the stack using an array.
4	Write C programs to implement a double ended queue ADT using i) array and ii) doubly linked list respectively.
5	Write a C program that uses functions to perform the following: a) Create a binary search tree of characters. b) Traverse the above Binary search tree recursively in Postorder.
6	Write a C program that uses functions to perform the following: a) Create a binary search tree of integers. b) Traverse the above Binary search tree non recursively in inorder.
7	Write C programs for implementing the following sorting methods to arrange a list of integers in ascending order: a) Insertion sort b) Merge sort
8	Write C programs for implementing the following sorting methods to arrange a list of integers in ascending order: a) Quick sort b) Selection sort
9	i) write a C program to perform the following operation: A) Insertion into a B-tree ii) Write a C program for implementing Heap sort algorithm for sorting a given list of integers in ascending order.
10	Write a C program to implement all the functions of a dictionary (ADT) using hashing.
11	Write a C program for implementing Knuth-Morris- Pratt pattern matching algorithm.
12	Write C programs for implementing the following graph traversal algorithms: a)Depth first traversal b)Breadth first traversal
13	Write a C Program to check whether two given lists are containing the same data.
14	Write a C program to find the largest element in a given doubly linked list.
15	Write a C program to reverse the elements in the stack using recursion.
16	Write a C program to implement stack using linked list.
17	Write a C program to count the number of nodes in the binary search tree.
18	Write a C program to sort an array of integers in ascending order using radix sort.
19	Write a C program to sort a given list of strings.

DATA STRUCTURES LABORATORY

OBJECTIVE:

The objective of this lab is to teach students various data structures and to explain them algorithms for performing various operations on these data structures. This lab complements the data structures course. Students will gain practical knowledge by writing and executing programs in C using various data structures such as arrays, linked lists, stacks, queues, trees, graphs, hash tables and search trees.

OUTCOMES:

Upon the completion of Data Structures practical course, the student will be able to:

1. **Design** and analyze the time and space efficiency of the data structure.
2. **Identity** the appropriate data structure for given problem.
3. **Understand** the applications of data structures.
4. **Choose** the appropriate data structure and algorithm design method for a specified application.
5. **Understand** which algorithm or data structure to use in different scenarios.
6. **Understand** and apply fundamental algorithmic problems including Tree traversals, Graph traversals.
7. **Compare** different implementations of data structures and to recognize the advantages and disadvantages of them.
8. **Write** complex applications using structured programming methods.

EXPERIMENT 1

1.1 OBJECTIVE

1. To create a singly linked list of integers.
2. Delete a given integer from the above linked list.
3. Display the contents of the above list after deletion.

1.2 RESOURCE:

Turbo C

1.3 PROGRAM LOGIC

1. Create a node using structure
2. Dynamically allocate memory to node
3. Create and add nodes to linked list

1.4 PROCEDURE

Go to debug -> run or press CTRL + F9 to run the program.

1.5 SOURCE CODE

program to create a single linked list, delete the contents and display the contents

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
#include<math.h>
/*declaring a structure to create a node*/
struct node
{
    int data;
    struct node *next;
};
struct node *start;

/* inserting nodes into the list*/
/*function to insert values from beginning of the the single linked list*/
void insertbeg(void)
{
    struct node *nn;
    int a;
    /*allocating implicit memory to the node*/
    nn=(struct node *)malloc(sizeof(struct node));
    printf("enter data:");
    scanf("%d",&nn->data);
    a=nn->data;
    if(start==NULL)          /*checking if List is empty*/
    {
        nn->next=NULL;
        start=nn;
    }
    else
    {
        nn->next=start;
        start=nn;
    }
    printf("%d succ. inserted\n",a);
    return;
}
/*function to insert values from the end of the linked list*/
```

```
void insertend(void)
{
    struct node *nn,*lp;int b;
    nn=(struct node *)malloc(sizeof(struct node));
    printf("enter data:");
    scanf("%d",&nn->data);
    b=nn->data;
    if(start==NULL)
    {
        nn->next=NULL;
        start=nn;
    }
    else
    {
        lp=start;
        while(lp->next!=NULL)
        {
            lp=lp->next;
        }
        lp->next=nn;
        nn->next=NULL;
    }
    printf("%d is succ. inserted\n",b);
    return;
}
```

/*function to insert values from the middle of the linked list*/

```
void insertmid(void)
{
    struct node *nn,*temp,*ptemp;int x,v;
    nn=(struct node *)malloc(sizeof(struct node));
    if(start==NULL)
    {
        printf("sll is empty\n"); return;
    }
    printf("enter data before which no. is to be inserted:\n");
    scanf("%d",&x);
    if(x==start->data)
    {
        insertbeg();
        return;
    }
    ptemp=start;
    temp=start->next;
    while(temp!=NULL&&temp->data!=x)
    {
        ptemp=temp;
        temp=temp->next;
    }
    if(temp==NULL)
    {
        printf("%d data does not exist\n",x);
    }
    else
    {
            printf("enter data:");
            scanf("%d",&nn->data);
            v=nn->data;
            ptemp->next=nn;
```

```
            nn->next=temp;
            printf("%d succ. inserted\n",v);
        }
        return;
    }
    /*deletion operation*/
    void deletion(void)
    {
        struct node *pt,*t;
        int x;
        if(start==NULL)
        {
            printf("sll is empty\n");
            return;
        }
        printf("enter data to be deleted:");
        scanf("%d",&x);
        if(x==start->data)
        {
            t=start;
            /* assigning first node pointer to next nod pointer to delete a data
            from the starting of the node*/
            start=start->next;
            free(t);
            printf("%d is succ. deleted\n",x);
            return;
        }
        pt=start;
        t=start->next;
        while(t!=NULL&&t->data!=x)
        {
            pt=t;t=t->next;
        }
        if(t==NULL)
        {
            printf("%d does not exist\n",x);return;
        }
        else
        {
            pt->next=t->next;
        }
        printf("%d is succ. deleted\n",x);
        free(t);
        return;
    }
    void display(void)
    {
        struct node *temp;
        if(start==NULL)
        {
            printf("sll is empty\n");
            return;
        }
        printf("elements are:\n");
        temp=start;
        while(temp!=NULL)
        {
            printf("%d\n",temp->data);
```

```
            temp=temp->next;
        }
        return;
    }
    /* main program*/
    int main()
    {
        int c,a;    start=NULL;
        do
        {
            printf("1:insert\n2:delete\n3:display\n4:exit\nenter choice:");
            scanf("%d",&c);
            switch(c)
            {
                case 1:
                printf("1:insertbeg\n2:insert end\n3:insert mid\nenter choice:");
                scanf("%d",&a);
                switch(a)
                {
                    case 1:insertbeg(); break;
                    case 2:insertend(); break;
                    case 3:insertmid(); break;
                }
                break;
                case 2:deletion(); break;
                case 3:display(); break;
                case 4:printf("program ends\n");break;
                default:printf("wrong choice\n");
                break;
            }
        }while(c!=4);return 0;
    }
```

1.6 PRE LAB QUESTIONS

1. What is data structure
2. How the memory is allocated dynamically
3. What is linked list
4. What is node
5. What are the types of linked list

1.7 LAB ASSIGNMENT

1. Write a program to insert a node at first , last and at specified position of linked list
2. Write a program to delete a node from first, last and at specified position of linked list

1.8 POST LAB QUESTIONS

1. How to represent linked list
2. How will you traverse linked list in reverse order
3. List the advantages and disadvantages of linked list?

1.9 INPUT AND OUTPUT

```
geetha@iare:~
[geetha@iare ~]$ gcc week1.c
[geetha@iare ~]$ ./a.out
1:insert
 2:delete
 3:display
 4:exit
 enter choice:1
1:insertbeg
 2:insertend
3:insertmid
enter choice:1
enter data:30
30 succ inserted
1:insert
 2:delete
 3:display
 4:exit
 enter choice:1
1:insertbeg
 2:insertend
3:insertmid
enter choice:1
enter data:20
20 succ inserted
```

```
geetha@iare:~
 4:exit
 enter choice:3
elements are:
20
30
1:insert
 2:delete
 3:display
 4:exit
 enter choice:2
enter data to be deleted20
 20s succ deletion
1:insert
 2:delete
 3:display
 4:exit
 enter choice:3
elements are:
30
1:insert
 2:delete
 3:display
 4:exit
 enter choice:
```

EXPERIMENT 2

2.1 OBJECTIVE

1. Create a doubly linked list of integers.
2. Delete a given integer from the above doubly linked list.
3. Display the contents of the above list after deletion.

2.2 RESOURCE

Turbo C

2.3 PROGRAM LOGIC

1. Create a node using structure
2. Dynamically allocate memory to node
3. Create and add nodes to linked list

2.4 PROCEDURE

Go to debug -> run or press CTRL + F9 to run the program

2.5 SOURCE CODE

Program to create a double linked list to inserting, deleting and displaying the contents

```
#include<stdio.h>
#include<stdlib.h>
/*declaring a structure to create a node*/
struct node
{
     struct node *prev;
     int data;
     struct node *next;
};
struct node *start,*nt;
/* inserting nodes into the list*/
/*function to insert values from beginning of the the double linked list*/

void insertbeg(void)
{
    int a;
    struct node *nn,*temp;
/*allocating implicit memory to the node*/
    nn=(struct node *)malloc(sizeof(struct node));
    printf("enter data:");
    scanf("%d",&nn->data);
    a=nn->data;
    if(start==NULL)     /*checking if List is empty*/
    {
      nn->prev=nn->next=NULL;
      start=nn;
    }
   else
   {
     nn->next=start;
     nn->prev=NULL;
     start->prev=nn;
     start=nn;
   }
   printf("%d succ inserted \n",a);
```

```
}
/*function to insert values from the end of the linked list*/

void insertend(void)
{
    int b;
    struct node *nn,*lp;
    nn=(struct node *)malloc(sizeof(struct node));
    printf("enter data:");
    scanf("%d",&nn->data);
    b=nn->data;
    if(start==NULL)
   {
/* assigning first node pointer to next nod pointer to delete a data from the starting
   of the node*/

      nn->prev=nn->next=NULL;
      start=nn;
   }
   else
  {
     lp=start;
    while(lp->next!=NULL)
    {
      lp=lp->next;
    }
    nn->prev=lp;
    lp->next=nn;
    nn->next=NULL;
  }
 printf("%d succ inserted\n",b);
}
/*function to insert values from the middle of the linked list*/

void insertmid(void)
{
    struct node *nn,*temp,*ptemp;
    int x,c;
   if(start==NULL)
    {
       printf("dll is empty\n");
      return;
    }
    printf("enter data before which nn is to be inserted\n");
    scanf("%d",&x);
    if(x==start->data)
     {
       insertbeg();
     }
     ptemp=start;
     temp=start->next;
     while(temp->next!=NULL&&temp->data!=x)
     {
      ptemp=temp;
      temp=temp->next;
     }
    if(temp==NULL)
    {
```

```
        printf("%d does not exit\n",x);
      }
      else
      {
/*allocating implicit memory to the node*/

         nn=(struct node *)malloc(sizeof(struct node));
         printf("enter data");
         scanf("%d",&nn->data);
        c=nn->data;
        nn->data;
       nn->prev=ptemp;
       nn->next=temp;
       ptemp->next=nn;
       temp->prev=nn;
       printf("%d succ inserted \n",c);
    }
}
/*end of insertion operation*/
/*deletion operation*/
void deletion()
{
     struct node *pt,*t;
     int x;
     t=pt=start;
     if(start==NULL)
     {
         printf("dll is empty\n");
     }
     printf("enter data to be deleted:");
    scanf("%d",&x);
    if(x==start->data)
    {
      t=start;
      t=t->next;
      free(start);
      start=t;
      start=pt;
    }
    else
    {
      while(t->next!=NULL&&t->data!=x)
      {
        pt=t;    /*logic for traversing*/
        t=t->next;
      }
     if(t->next==NULL&&t->data==x)
     {
      free(t);
      pt->next=NULL;
     }
    else
     {
      if(t->next==NULL&&t->data!=x)
          printf("data not found");
      else
       {
         pt->next=t->next;
```

```
      free(t);
    }
  }
  printf("%d is succ deleted\n",x);
 }
}
```

/*end of deletion operation*/
/*display operation*/

```
void display()
{
    struct node *temp;
    if(start==NULL)
    printf("stack is empty ");
    temp=start;
    while(temp->next!=NULL)
    {
       printf("%d",temp->data);
       temp=temp->next;
    }
   printf("%d",temp->data);
 }
```

/*end of display operation*/
/*main program*/

```
int main()
{
    int c,a;
   start=NULL;
   do
   {
       printf("1.insert\n2.delete\n3.display\n4.exit\nenter choice:");
       scanf("%d",&c);
       switch(c)
       {
          case 1:printf("1.insertbeg\n2.insertend\n3.insertmid\nenter choice:");
                    scanf("%d",&a);
                    switch(a)
                    {
                           case 1:insertbeg();
                                     break;
                           case 2:insertend();
                                     break;
                           case 3:insertmid();
                                     break;
                    }
                   break;
         case 2:deletion();
                    break;
        case 3:display();
                    break;
       case 4:printf("program ends\n");
                   break;
       default:printf("wrong choice\n");
                   break;
    }
  }
  while(c!=4);
  return 0;
 }
```

2.6 PRE LAB QUESTIONS

1. What is double linked list
2. How to represent a node in double linked list
3. Differentiate between single and double linked list

2.7 LAB ASSIGNMENT

1. Write a program to insert a node at first , last and at specified position of double linkedlist
2. Write a program to eliminate duplicates from double linked list
3. Write a program to delete a node from first, last and at specified position of double linkedlist

2.8 POST LAB QUESTIONS

1. How to represent double linked list
2. How will you traverse double linked list
3. List the advantages of double linked list over single list

2.9 INPUT AND OUTPUT

```
geetha@iare:~
[geetha@iare ~]$ clear
[geetha@iare ~]$ gcc w-2.c
[geetha@iare ~]$ ./a.out
1.insert
2.delete
3.display
4.exit
enter choice:1
1.insertbeg
2.insertend
3.insertmid
enter choice:1
enter data:30
30 succ inserted
1.insert
2.delete
3.display
4.exit
enter choice:1
1.insertbeg
2.insertend
3.insertmid
enter choice:1
enter data:20
```

```
geetha@iare:~
20 succ inserted
1.insert
2.delete
3.display
4.exit
enter choice:
3
20301.insert
2.delete
3.display
4.exit
enter choice:2
enter data to be deleted:30
30 is succ deleted
1.insert
2.delete
3.display
4.exit
enter choice:3
201.insert
2.delete
3.display
4.exit
enter choice:
```

EXPERIMENT 3

3.1 OBJECTIVE
To convert a given infix expression into its postfix Equivalent, Implement the stack using an array.

3.2 RESOURCE:
Turbo C

3.3 PROGRAM LOGIC
1. Create a stack
2. Read an infix expression
3. convert infix exression into postfix expression

3.4 PROCEDURE:
Go to debug -> run or press CTRL + F9 to run the program

3.5 SOURCE CODE:

Program to convert a given infix expression into its postfix Equivalent, Implement the stack using an array.

```
#include<stdio.h>
#include<string.h>
#include<stdlib.h>
#define MAX 20
char stack[MAX];
int top=1;
char pop(); /*declaration of pop function*/
void push(char item); /*declaration of push function*/
int prcd(char symbol) /*checking the precedence*/
{
  switch(symbol) /*assigning values for symbols*/
  {
    case '+':
    case '-': return 2;
    break;
    case '*':
    case '/': return 4;
    break;
    case '^':return 6;
    break;
    case '(':
    case ')':
    case '#':return 1;
   break;
  }
}
int(isoperator(char symbol)) /*assigning operators*/
{
  switch(symbol)
  {
     case '+':
     case '*':
```

```
    case '-':
    case '/':
    case '^':
    case '(':
    case ')':return 1;
    break;
    default:return 0;
  }
 }
/*converting infix to postfix*/
void convertip(char infix[],char postfix[])
{
 int i,symbol,j=0;
 stack[++top]='#';
 for(i=0;i<strlen(infix);i++)
 {
  symbol=infix[i];
  if(isoperator(symbol)==0)
  {
    postfix[j]=symbol;
     j++;
  }
  else
  {
    if(symbol=='(')
    push(symbol); /*function call for pushing elements into the stack*/
    else if(symbol==')')
    {
      while(stack[top]!='(')
      {
        postfix[j]=pop();
        j++;
      }
      pop();    /*function call for popping elements into the stack*/
   }
   else
   {
      if(prcd(symbol)>prcd(stack[top]))
      push(symbol);
      else
      {
       while(prcd(symbol)<=prcd(stack[top]))
       {
        postfix[j]=pop();
         j++;
       }
       push(symbol);
      }/*end of else loop*/
    }/*end of else loop*/
   } /*end of else loop*/
  }/*end of for loop*/
 While (stack[top]!='#')
  {
   postfix[j]=pop();
    j++;
  }
  postfix[j]='\0'; /*null terminate string*/
}
```

```
/*main program*/
void main()
 {
     char infix[20],postfix[20];
     printf("enter the valid infix string \n");
     gets(infix);
     convertip(infix,postfix);     /*function call for converting infix to postfix */
     printf("the corresponding postfix string is:\n");
    puts(postfix);
  }
/*push operation*/
void push(char item)
{
   top++;
   stack[top]=item;
 }
/*pop operation*/
char pop()
{
   char a;
   a=stack[top];
   top--;
   return a;
 }
```

3.6 PRE LAB QUESTIONS

1. what is an expression
2. what are infix, prefix and postfix notations
3. what are polish and reverse polish notations
4. which data structure is used for infix to postfix conversion

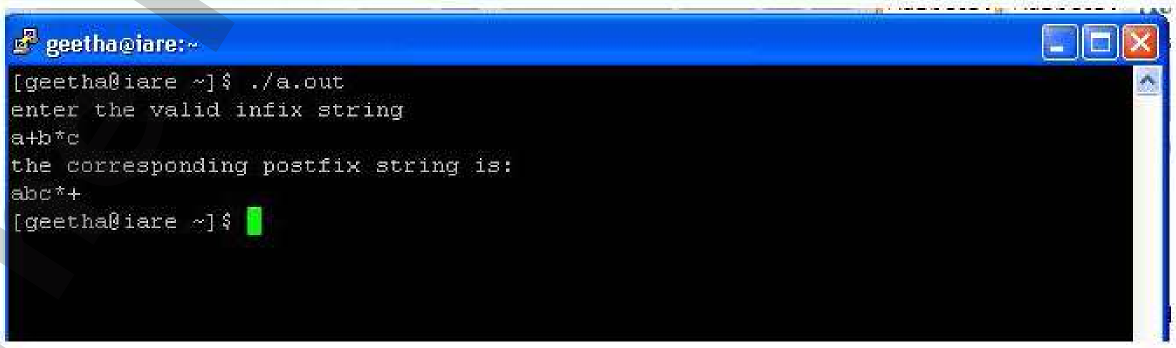
3.7 LAB ASSIGNMENT

1. Convert the infix expression (a+b)-(c*d) into post fix form?
2. Convert the following expression A + (B * C) - ((D * E + F) / G) into post form.

3.8 POST LAB QUESTIONS

1. how to represent stack
2. why reverse polish notation is required
3. can we evaluate polish notation

3.9 INPUT AND OUTPUT



EXPERIMENT 4

4.1 OBJECTIVE
1. To implement a double ended queue ADT using arrays.
2. To implement a double ended queue ADT using doubly linked list.

4.2 RESOURCE:
Turbo C

4.3 PROGRAM LOGIC
Double ended queue ADT using arrays
1. Create a linked list
2. Perform all the operation of double ended queue using arrays
3. Display the content of queue at last.

Double ended queue ADT using doubly linked list
1. Create a linked list
2. Perform all the operation of double ended queue using linked list
3. Display the content of queue at last.

4.4 PROCEDURE:
Go to debug -> run or press CTRL + F9 to run the program

4.5 SOURCE CODE:

Programs to implement a double ended queue ADT using arrays

```
#include<stdio.h>
#define SIZE 30
int dequeue[SIZE];
int front=-1,rear=-1; /* initializing front and rear*/
void insertrear(int);
void deletefront();
void insertfront(int);
void deleterear();
void traverse();
/*main program*/
void main()
{
      int choice,item;
      char ch;
      do
      {
         printf("\n options are");
         printf("\n press 1 to insert at rear");
         printf("\n press 2 to delete at front");
         printf("\n press 3 to insert at front");
         printf("\n press 4 to delete at rear");
         scanf("%d",&choice);
         switch(choice)    /*switch case*/
         {
            case 1: printf("\n enter the element:");
                    scanf("%d",&item);
                    insertrear(item); /*function call for inserting element at rear*/
                    break;
            case 2: deletefront(); /*function call for deleting element at front*/
```

```
                break;
            case 3: printf("enter the element:");
                scanf("%d",&item);
                insertfront(item); /*function call for inserting element at front*/
                break;
            case 4: deleterear();/*function call for deleting element at rear*/
                break;
            case 5: traverse(); /*traversing the list*/
                break;
            default : printf("wrong choice");
        } /*end of switch case*/
        printf("\n do you want to perform more operations?(Y/N):");
        fflush(stdin);
        scanf(" %c",&ch);
    } while(ch=='Y'||ch=='y');
}

/*insertion at rear*/
void insertrear(int value) /*function definition*/
{
    if(rear==(SIZE-1))
    {
        printf("overflow");
        return;
    }
    else
    {
        if(front==-1)
        {
            printf("underflow so front will be modified");
            front=front+1;
        }
        rear=rear+1;
        dequeue[rear]=value;
    }
}

/*deletion at front*/
void deletefront() /*function definition*/
{
    int value;
    if(front==-1)
    {
        printf("queue is already empty");
        value=-1;
    }
    else
    {
        value=dequeue[front];
        if(front==rear)
        {
            printf("queue contains only one item");
            rear=-1;
            front=-1;
        }
        else
        front=front+1;
    }
```

```
  printf("removed element from front is %d",value);
}

/*insertion at front*/
void insertfront(int value) /*function definition*/
{
    if(front==0)
    {
       printf("front is at the beginning");
      printf("here insertion is not possible");
      return;
    }
    else
    {
     if(front==-1)
    {
       printf("queue is empty so both pointers will modified");
      front=front+1;
      rear=rear+1;
     }
     else
    {
      front=front-1;
    }
    dequeue[front]=value;
  }
}

/*deletion at rear*/
void deleterear() /*function definition*/
{
    int value;
    if(front==-1)
    {
            printf("queue is already empty");
            return;
    }
   else
  {
      value=dequeue[rear];
      if(rear==front)
      {
        printf("queue contains only one item");
        printf("rear and front will be modified");
        rear=-1;
        front=-1;
      }
     else
     {
       rear=rear-1;
      }
  }
   printf("\n the removed element from rear is:%d",value);
}
/*traverse operation*/
void traverse() /*function definition*/
{
     int i;
```

```
        if(front==-1)
        {
           printf("queue empty");
           return;
        }
       else
        {
           printf("\n value in the queue are as follow:");
          for(i=front;i<=rear;i++)
          printf("\n%d",dequeue[i]);
        }
     }
```

program to implement double ended queue adt using doubly linked list

```
#include <stdio.h>
 #include <stdlib.h>
/*declaring a structure to create a node*/

  struct node
{
        int data;
        struct node *prev, *next;
  };

  struct node *head = NULL, *tail = NULL;

  struct node * createNode(int data)
  {
/*allocating implicit memory to the node*/

        struct node *newnode = (struct node *)malloc(sizeof (struct node));
        newnode->data = data;
        newnode->next = newnode->prev = NULL;
        return (newnode);
  }

   /* create sentinel(dummy head & tail) that helps us to do insertion and deletion
    operation at front and rear so easily. And these dummy head and tail wont get deleted
    till the end of execution of this program  */

  void createSentinels() /*creating a head and tail*/
  {
        head = createNode(0);
        tail = createNode(0);
        head->next = tail;
        tail->prev = head;
  }

  /* insertion at the front of the queue */
  void enqueueAtFront(int data)
  {
        struct node *newnode, *temp;
        newnode  = createNode(data);
        temp = head->next;
        head->next  = newnode;
        newnode->prev  = head;
        newnode->next  = temp;
        temp->prev = newnode;
```

```
}
```

/*insertion at the rear of the queue */

```
void enqueueAtRear(int data)
{
      struct node *newnode, *temp;
      newnode = createNode(data);
      temp = tail->prev;
      tail->prev = newnode;
      newnode->next = tail;
      newnode->prev = temp;
      temp->next = newnode;
}
```

/* deletion at the front of the queue */

```
void dequeueAtFront()
{
      struct node *temp;
      if (head->next == tail)
      {
            printf("Queue is empty\n");
      }
      Else
      {
            temp = head->next;
            head->next = temp->next;
            temp->next->prev = head;
            free(temp);
       }
       return;
}
```

/* deletion at the rear of the queue */

```
void dequeueAtRear()
{
      struct node *temp;
      if (tail->prev == head)
      {
            printf("Queue is empty\n");
      }
      Else
       {
            temp = tail->prev;
            tail->prev = temp->prev;
            temp->prev->next = tail;
            free(temp);
      }
      return;
}
```

/* display elements present in the queue */

```
void display()
{
      struct node *temp;
      if (head->next == tail)
       {
```

```
            printf("Queue is empty\n");
            return;
        }

        temp = head->next;
        while (temp != tail)
        {
            printf("%-3d", temp->data);
            temp = temp->next;
        }
        printf("\n");
  }

/*main program*/
  int main()
  {
        int data, ch;
        createSentinels();
        while (1)
        {
            printf("1. Enqueue at front\n2. Enqueue at rear\n");
            printf("3. Dequeue at front\n4. Dequeue at rear\n");
            printf("5. Display\n6. Exit\n");
            printf("Enter your choice:");
            scanf("%d", &ch);
            switch (ch) /*switch case*/
            {
                case 1:
                    printf("Enter the data to insert:");
                    scanf("%d", &data);
                    enqueueAtFront(data);
                    break;

                case 2:
                    printf("Enter ur data to insert:");
                    scanf("%d", &data);
                    enqueueAtRear(data);
                    break;

                case 3:
                    dequeueAtFront();
                    break;

                case 4:
                    dequeueAtRear();
                    break;

                case 5:
                    display();
                    break;

                case 6:
                    exit(0);

                default:
                    printf("Pls. enter correct option\n");
                    break;
            } /*end of switch case*/
```

```
        }
        return 0;
    }
```

4.6 PRE LAB QUESTIONS

1. what is queue and its operations
2. what is double ended queue
3. differentiate queue and double ended queue

4.7 LAB ASSIGNMENT

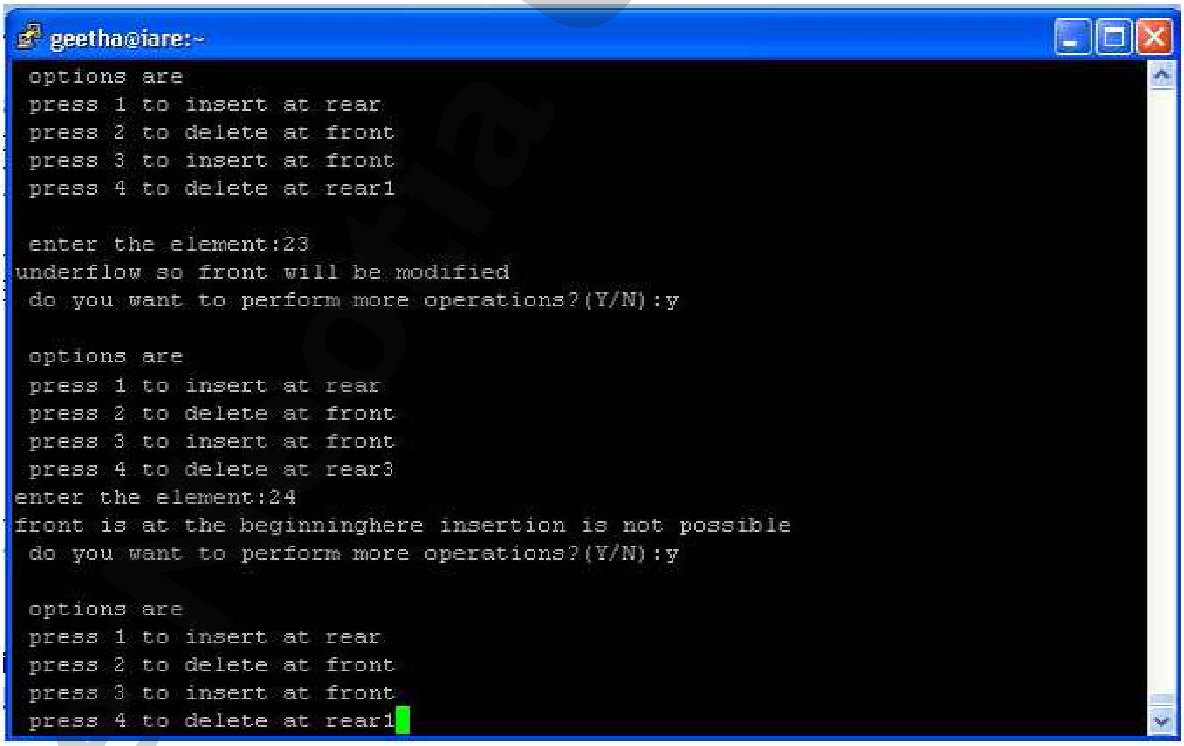
1. Write a program to insert an element when rear is at last position
2. Write a program to delete an element when front is at last position

4.8 POST LAB QUESTIONS

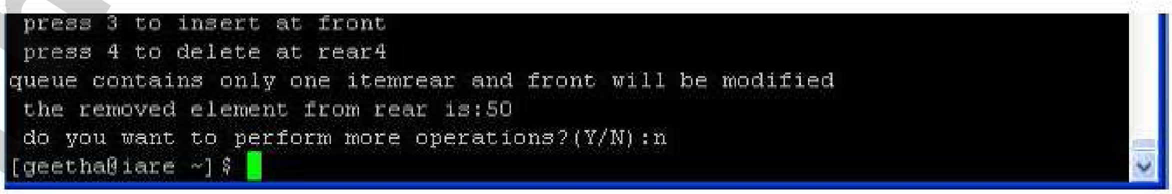
1. Write the condition for queue full
2. Write the condition for queue empty
3. List the advantages of double ended queue over queue

4.9 INPUT AND OUTPUT

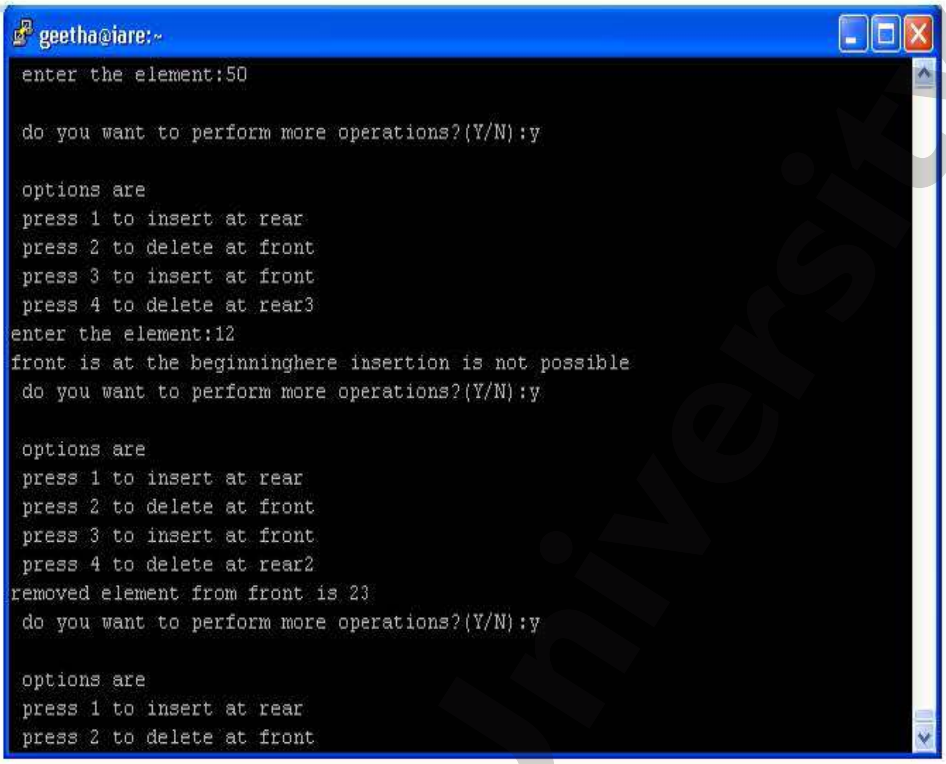
<u>A double ended queue ADT using arrays</u>



```
geetha@iare:~
 options are
 press 1 to insert at rear
 press 2 to delete at front
 press 3 to insert at front
 press 4 to delete at rear1

 enter the element:23
underflow so front will be modified
 do you want to perform more operations?(Y/N):y

 options are
 press 1 to insert at rear
 press 2 to delete at front
 press 3 to insert at front
 press 4 to delete at rear3
enter the element:24
front is at the beginninghere insertion is not possible
 do you want to perform more operations?(Y/N):y

 options are
 press 1 to insert at rear
 press 2 to delete at front
 press 3 to insert at front
 press 4 to delete at rear1
```

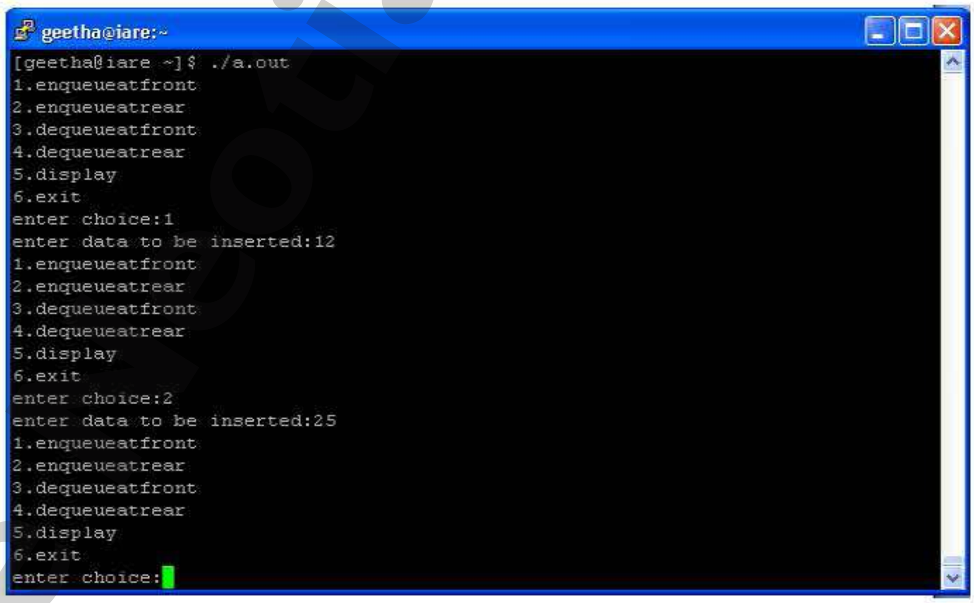


```
 press 3 to insert at front
 press 4 to delete at rear4
queue contains only one itemrear and front will be modified
 the removed element from rear is:50
 do you want to perform more operations?(Y/N):n
[geetha@iare ~]$
```



```
geetha@iare:~
 enter the element:50

 do you want to perform more operations?(Y/N):y

 options are
 press 1 to insert at rear
 press 2 to delete at front
 press 3 to insert at front
 press 4 to delete at rear3
enter the element:12
front is at the beginninghere insertion is not possible
 do you want to perform more operations?(Y/N):y

 options are
 press 1 to insert at rear
 press 2 to delete at front
 press 3 to insert at front
 press 4 to delete at rear2
removed element from front is 23
 do you want to perform more operations?(Y/N):y

 options are
 press 1 to insert at rear
 press 2 to delete at front
```

<u>double ended queue adt using doubly linked list</u>



```
geetha@iare:~
[geetha@iare ~]$ ./a.out
1.enqueueatfront
2.enqueueatrear
3.dequeueatfront
4.dequeueatrear
5.display
6.exit
enter choice:1
enter data to be inserted:12
1.enqueueatfront
2.enqueueatrear
3.dequeueatfront
4.dequeueatrear
5.display
6.exit
enter choice:2
enter data to be inserted:25
1.enqueueatfront
2.enqueueatrear
3.dequeueatfront
4.dequeueatrear
5.display
6.exit
enter choice:
```

geetha@iare:~

```
enter choice:1
enter data to be inserted:26
1.enqueueatfront
2.enqueueatrear
3.dequeueatfront
4.dequeueatrear
5.display
6.exit
enter choice:2
enter data to be inserted:65
1.enqueueatfront
2.enqueueatrear
3.dequeueatfront
4.dequeueatrear
5.display
6.exit
enter choice:3
1.enqueueatfront
2.enqueueatrear
3.dequeueatfront
4.dequeueatrear
5.display
6.exit
enter choice:
```

```
enter choice:4
1.enqueueatfront
2.enqueueatrear
3.dequeueatfront
4.dequeueatrear
5.display
6.exit
enter choice:5
12 25
1.enqueueatfront
2.enqueueatrear
3.dequeueatfront
4.dequeueatrear
5.display
6.exit
enter choice:6
[geetha@iare ~]$
```

EXPERIMENT 5

5.1 OBJECTIVE

1. To create a binary search tree of characters.
2. Traverse the above Binary search tree recursively in Post order.

5.2 RESOURCE:

Turbo C

5.3 PROGRAM LOGIC

1. Create binary tree with the property binary search tree
2. Visit the tree in post order
3. Visit in the order left, right, root
4. Display the visited nodes

5.4 PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program

5.5 SOURCE CODE:

/*program for creating and traversing the binary search tree*/

```
#include<stdio.h>
#include<stdlib.h>
typedef struct BST
{
    char d;
/*declaring a structure to create a node*/

   struct BST *lc,*rc;
}node;
/*main program*/
void main()
{
   int choice;
   char ans='N';
   int key;
    node *nn,*root,*parent;
    root=NULL;
    printf("\n program for binary search tree");
    do
    {
      printf("\n 1.create");
      printf("\n 2.resurcive traverse");
      printf("\n 3.exit");
      printf("\n enter your choice");
      scanf("%d",&choice);
      switch(choice) /*switch case*/
      {
        case 1:
                    do
                    {
                          nn=(node *)malloc(sizeof(node));
                          printf("\n enter the elements");
                          nn->lc=NULL;
```

```
                        nn->rc=NULL;
                        scanf(" %c",&nn->d);
                        if(root==NULL)
                        root=nn;
                       else
                          insert(root,nn);
                        printf("\n want to enter more elements?(Y/N)");
                        scanf(" %c",&ans);
                   }while(ans=='y');
                  break;
      case 2:
                   if(root==NULL)
                  printf("tree is not created");
                  else
                  {
                        printf("\n the inorder display:");
                        inorder(root);
                       printf("\n the preorder display:");
                       preorder(root);
                      printf("\n the postorder display:");
                      postorder(root);
                  }
                  break;
     } /*end of switch case*/
   }while(choice!=3);
 }
/*insertion operation*/
void insert(node *root,node *nn)
{
   int c,d;
   c=nn->d;
   d=root->d;
   if(c<d)
   {
     if(root->lc==NULL)
     root->lc=nn;
    else
      insert(root->lc,nn);
   }
}
/*inorder traversal*/
void inorder(node *temp)
{
   if(temp!=NULL)
   {
     inorder(temp->lc);
     printf(" %c",temp->d);
     inorder(temp->rc);
   }
}
/*preorder traversal*/
void preorder(node *temp)
{
  if(temp!=NULL)
  {
    printf(" %c",temp->d);
    preorder(temp->lc);
    preorder(temp->rc);
```

```
  }
}
/*postorder traversal*/
void postorder(node *temp)
{
  if(temp!=NULL)
  {
    postorder(temp->lc);
    postorder(temp->rc);
    printf(" %c",temp->d);
  }
}
```

5.6 PRE LAB QUESTIONS

1. Differentiate between BST and complete BST
2. What are the properties of BST
3. How many nodes will be there in given nth level.

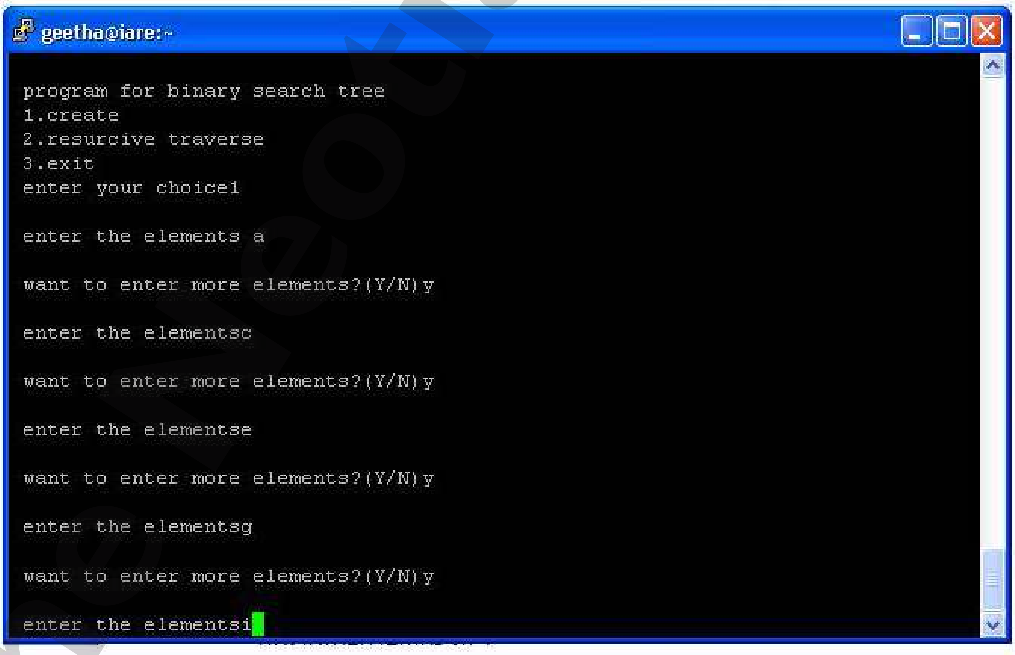
5.7 LAB ASSIGNMENT

1. Construct a binary search tree for the following 80, 40, 75, 30, 20, 90, 50

5.8 POST LAB QUESTIONS

1. List the various tree traversal techniques are there
2. Write the necessary condition for inserting element into BST
3. List the applications of BST

5.9 INPUT AND OUTPUT



EXPERIMENT 6

6.1 OBJECTIVE
1. Create a binary search tree of integers.
2. Traverse the above Binary search tree non recursively in inorder.

6.2 RESOURCE:
Turbo C

6.3 PROGRAM LOGIC
1. Read integers
2. Create binary tree with the property binary search tree
3. Visit the tree in inorder
4. Visit in the order left, root, right,
5. Display the visited nodes

6.4 PROCEDURE
Go to debug -> run or press CTRL + F9 to run the program

6.5 SOURCE CODE:

```
/*creating binary search tree of integer*/

#include<stdio.h>
#include<conio.h>
typedef struct bint
{
/*declaring a structure to create a node*/

   int data,flag;
   struct bint *left,*right;
}node;
node * create(node *r,int d)
{
    if(r == NULL)
    {
/*allocating implicit memory to the node*/

       r = (node *)malloc(sizeof(node));
       r->data = d;
       r->left = r->right = NULL;
    }
    else
   {
    if(r->data <= d)
       r->right = create(r->right,d);
    else
       r->left = create(r->left,d);
   }
  return r;
}
void non_in(node *r)
{
    int top=0;
    node *s[20],*pt=r;
    s[0]=NULL;
```

```
while(pt != NULL)
{
  s[++top] = pt;
  pt = pt->left;
}
pt = s[top--];
while(pt != NULL)
{
   printf("%d\t",pt->data);
   if(pt->right != NULL)
   {
     pt = pt->right;
     while(pt != NULL)
     {
       s[++top] = pt;
       pt = pt->left;
     }
   }
   pt = s[top--];
  }
}
/*main program*/
void main()
{
  int d;
  char ch = 'Y';
  node *root = NULL;
  clrscr();
  while(toupper(ch) == 'Y')
  {
    printf("\n Enter the item to insert");
    scanf("%d",&d);
    head = create(root,d);
    printf("\n Do you want to continue(y/n)");
    fflush(stdin);
    ch = getchar();
  }

  printf("\n inorder non recursive\n");
  non_in(head);
}
```

6.6 PRE LAB QUESTIONS

1. Differentiate between BST and complete BST
2. What are the properties of BST
3. How many nodes will be there in given nth level.

6.7 LAB ASSIGNMENT

1 Construct a binary search tree for the following 80, 40, 75, 30, 20, 90, 50

6.8 POST LAB QUESTIONS

1. List the various tree traversal techniques are there
2. Write the necessary condition for inserting element into BST
3. List the applications of BST

6.9 INPUT AND OUTPUT

```
[geetha@iare ~]$ ./a.out
enter the item to insert12

 do you want to continue (Y/N)y
enter the item to insert34

 do you want to continue (Y/N)y
enter the item to insert56

 do you want to continue (Y/N)y
enter the item to insert78

 do you want to continue (Y/N)n

 inorder non recursive
12      34      56      78      [geetha@iare ~]$
```

EXPERIMENT 7

7.1 OBJECTIVE

1. Arrange a list of integers in ascending order using Insertion sort
2. Arrange a list of integers in ascending order using Merge sort

7.2 RESOURCE

Turbo C

7.3 PROGRAM LOGIC.

INSERTION SORT

1. Start with an empty left hand [sorted array] and the cards face down on the table [unsorted array].
2. Then remove one card [key] at a time from the table [unsorted array], and insert it into the correct position in the left hand [sorted array].
3. To find the correct position for the card, we compare it with each of the cards already in the hand, from right to left.

MERGE SORT

1. **Divide Step**
   If a given array A has zero or one element, simply return; it is already sorted. Otherwise, split $A[p .. r]$ into two subarrays $A[p .. q]$ and $A[q + 1 .. r]$, each containing about half of the elements of $A[p .. r]$. That is, q is the halfway point of $A[p .. r]$.
2. **Conquer Step**
   Conquer by recursively sorting the two subarrays $A[p .. q]$ and $A[q + 1 .. r]$.
3. **Combine Step**
   Combine the elements back in $A[p .. r]$ by merging the two sorted subarrays $A[p .. q]$ and $A[q + 1 .. r]$ into a sorted sequence. To accomplish this step, we will define a procedure MERGE (A, p, q, r).

7.4 PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program

7.5 SOURCE CODE:.

Insertion sort

```
#include<stdio.h>
void inst_sort(int[]);
void main() {
    int num[5],count;
    printf("\n enter the five elements to sort:\n");
    for(count=0;count<5;count++)
    scanf("%d",&num[count]);
    inst_sort(num); /*function call for insertion sort*/
    printf("\n\n elements after sorting:\n");
    for(count=0;count<5;count++)
    printf("%d\n",num[count]);
}
void inst_sort(int num[]) { /* function definition for insertion sort*/
   int i,j,k;
   for(j=1;j<5;j++)      {
     k=num[j];
     for(i=j-1;i>=0&&k<num[i];i--)
```

```
                num[i+1]=num[i];
                num[i+1]=k;
        }}
```

Merge sort

```
#include<stdio.h>
void mergesort(int[],int,int);
void mergearray(int[],int,int,int);
main() {
    int a[50],n,i;
   printf("\n enter size of an array:");
   scanf("%d",&n);
    printf("\n enter elements of an array:\n");
    for(i=0;i<n;i++)
      scanf("%d",&a[i]);
    mergesort(a,0,n-1);
    printf("\n\nafter sorting:\n");
    for(i=0;i<n;i++)
    printf("\n%d",a[i]);
}
/*merge operation*/
void mergesort(int a[],int beg,int end) {
   int mid;
   if(beg<end)    {
    mid=(beg+end)/2;
    mergesort(a,beg,mid);
    mergesort(a,mid+1,end);
    mergearray(a,beg,mid,end);
  } }
void mergearray(int a[],int beg,int mid,int end) {
   int i,leftend,num,temp,j,k,b[50];
   for(i=beg;i<=end;i++)
   b[i]=a[i];
   i=beg;
   j=mid+1;
   k=beg;
   while((i<=mid)&&(j<=end))     {
   if(b[i]<+b[j])
   {
     a[k]=b[i];
     i++;
     k++;
   }
  else    {
     a[k]=b[j];
     j++;
     k++;
   } }

 if(i<=mid) {
   while(i<=mid)     {
     a[k]=b[i];
     i++;
     k++;
   } }
  else {
   while(j<=end)  {
```

```
                a[k]=b[j];
                j++;
                k++;
            } } }
```

7.6 PRE LAB QUESTIONS

1. what is sorting
2. List the various sorting algorithms
3. What is the advantage of insertion sort
4. How merge sort works
5. Is insertion sort is stable algorithm

7.7 LAB ASSIGNMENT

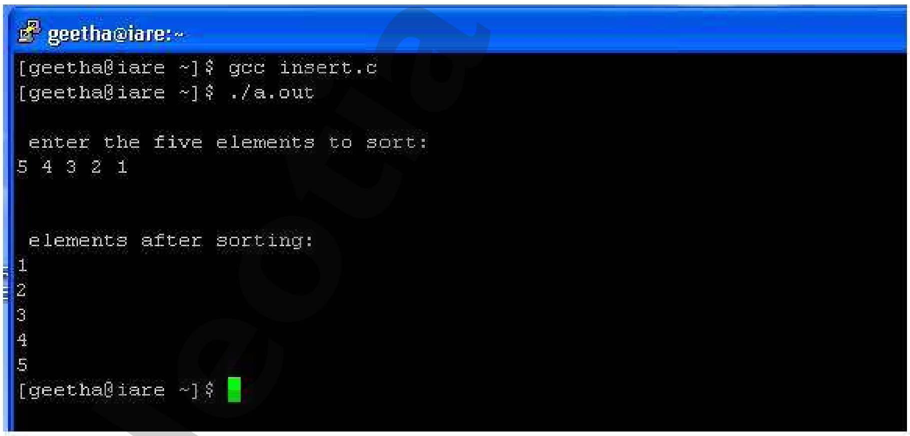
1. Apply the selection sort on the following elements21,11,5,78,49, 54,72,88
2. Apply the merge sort on the following elements21,11,5,78,49, 54,72,88 and 56,28,10

7.8 POST LAB QUESTIONS

1. What is the time complexity of insertion sort
2. What is the time complexity of merge sort
3. Why sorting is required
4. Is merge sort is in place
5. List the application of merge sort

7.9 INPUT AND OUTPUT

Insertion sort



Merge sort

EXPERIMENT 8

8.1. OBJECTIVE

1. Sorting the list of integers in ascending order using Quick sort
2. Sorting the list of integers in ascending order using Selection sort

8.2 RESOURCE:

Turbo C

8.3 PROGRAM LOGIC

Quick sort

1. Read the elements to be sort
2. Find the proper pivot element
3. Apply quick sort method to sort the remaining elements

Selection sort

1. Read the elements to be sort
2. Select the minimum element
3. Apply the selection sort to sort the remaining elements

8.4 PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program

8.5 SOURCE CODE:.

QUICK SORT

```
#include<stdio.h>
main()
{
    int x[10],i,n;
   printf("enter number of elements:");
   scanf("%d",&n);
   printf("enter %d elements:\n");
   for(i=0;i<n;i++)
   scanf("%d",&x[i]);
   quicksort(x,0,n-1);/*function call*/
   printf("sorted elements are:");
   for(i=0;i<n;i++)
     printf("%3d",x[i]);
}
/*called function*/
quicksort(int x[10],int first,int last)
{
    int pivot,i,j,t;
    if(first<last)
    {
      pivot=first;
      i=first;
      j=last;
      while(i<j)
      {
        while(x[i]<=x[pivot]&&i<last)
        i++;
       while(x[j]>x[pivot])
        j--;
      if(i<j)
```

```
            {
              t=x[i];
              x[i]=x[j];
              x[j]=t;
            }
          }
          t=x[pivot];
          x[pivot]=x[j];
          x[j]=t;
          quicksort(x,first,j-1);
          quicksort(x,j+1,last);
        }
      }
```

SELECTION SORT

```
#include<stdio.h>
void sel_sort(int[]);
void main()
{
    int num[5],count;
   printf("enter the five elements to sort:\n");
   for(count=0;count<5;count++)
     scanf("%d",&num[count]);
   sel_sort(num); /*function call*/
   printf("\n\n elements after sorting:\n");
   for(count=0;count<5;count++)
     printf("%d\n",num[count]);
}
/*called function*/
void sel_sort(int num[])
{
   int i,j,min,temp;
   for(j=0;j<5;j++)
   {
     min=j;
     for(i=j;i<5;i++)
     if(num[min]>num[i])
     min=i;
    if(min<5)
    {
        temp=num[j];
        num[j]=num[min];
        num[min]=temp;
    }
    printf("%d\t",num[j]);
   }
}
```

8.6 PRE LAB QUESTIONS

1. what is sorting
2. List the various sorting algorithms
3. What is the advantage of selection sort
4. How to find pivot element in quick sort
5. Is quick sort is stable algorithm

8.7 LAB ASSIGNMENT

1 . Rearrange the following numbers using Quick sort procedure. 42, 12, 18, 98, 67, 83, 8, 10, 71

2.Apply the selection sort on the following elements21,11,5,78,49, 54,72,88

8.8 POST LAB QUESTIONS

6. What is the time complexity of selection sort
7. What is the time complexity of quick sort
8. Why sorting is required
9. Is selection sort is stable
10. What is the worst case for quick sort

8. 9 INPUT AND OUTPUT,

QUICK SORT

```
geetha@iare:~
[geetha@iare ~]$ gcc quick.c
[geetha@iare ~]$ ./a.out
enter number of elements:5
enter 1 elements:
5 4 3 2 1
sorted elements are:  1  2  3  4  5[geetha@iare ~]$
```

SELECTION SORT

```
geetha@iare:~
[geetha@iare ~]$ gcc sel.c
[geetha@iare ~]$ ./a.out
enter the five elements to sort:
5
4
3
2
1
1       2       3       4       5

 elements after sorting:
1
2
3
4
5
[geetha@iare ~]$
```

EXPERIMENT 9

9.1 OBJECTIVE

1. To perform the Insertion into a B-tree
2. Implement Heap sort algorithm

9.2 RESOURCE:

Turbo C

9.3 PROGRAM LOGIC

B-tree

1. Read the elements
2. Use the properties B-Tree and construct B-Tree
3. Select the required operation

Heap sort

4. Read the elements to be sort
5. Construct the heap
6. Sort the above heap using deletion

9.4 PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program

9.5 SOURCE CODE:

B-TREE

```
#include<stdio.h>
#include <stdlib.h>
#define M 5
struct node
{
int n; /* n < M No. of keys in node will always less than order of B
                tree */
int keys[M-1];      /*array of keys*/
struct node *p[M]; /* (n+1 pointers will be in use) */
}*root=NULL;

enum KeyStatus { Duplicate,SearchFailure,Success,InsertIt,LessKeys };
void insert(int key);
void display(struct node *root,int);
void search(int x);
enum KeyStatus ins(struct node *r, int x, int* y, struct node** u);
int searchPos(int x,int *key_arr, int n);
int main()
{
int key;
int choice;
printf("Creation of B tree for node %d\n",M);
while(1)
{
printf("1.Insert\n");
printf("3.Search\n");
printf("4.Display\n");
printf("5.Quit\n");
printf("Enter your choice : ");
scanf("%d",&choice);
```

```
switch(choice)
{
        case 1:
                printf("Enter the key : ");
                scanf("%d",&key);
                insert(key);
                break;


        case 3:
                printf("Enter the key : ");
                scanf("%d",&key);
                search(key);
                break;
        case 4:
                printf("Btree is :\n");
                display(root,0);
                break;
        case 5:
                exit(1);
        default:
                printf("Wrong choice\n");
                break;
        }/*End of switch*/
        }/*End of while*/
return 0;
}/*End of main()*/
void insert(int key)
{
struct node *newnode;
int upKey;
enum KeyStatus value;
value = ins(root, key, &upKey, &newnode);
if (value == Duplicate)
printf("Key already available\n");
if (value == InsertIt)
{
struct node *uproot = root;
root=malloc(sizeof(struct node));
root->n = 1;
root->keys[0] = upKey;
root->p[0] = uproot;
root->p[1] = newnode;
}/*End of if */
}/*End of insert()*/

enum KeyStatus ins(struct node *ptr, int key, int *upKey,struct node**newnode)
{
struct node *newPtr, *lastPtr;
int pos, i, n,splitPos;
int newKey, lastKey;
enum KeyStatus value;
if (ptr == NULL)
{
*newnode = NULL;
*upKey = key;
return InsertIt;
```

```
}
n = ptr->n;
pos = searchPos(key, ptr->keys, n);
if (pos < n && key == ptr->keys[pos])
return Duplicate;
value = ins(ptr->p[pos], key, &newKey, &newPtr);
if (value != InsertIt)
return value;
/*If keys in node is less than M-1 where M is order of B tree*/
if (n < M - 1)
{
pos = searchPos(newKey, ptr->keys, n);
/*Shifting the key and pointer right for inserting the new key*/
for (i=n; i>pos; i--)
{
ptr->keys[i] = ptr->keys[i-1];
ptr->p[i+1] = ptr->p[i];
}
/*Key is inserted at exact location*/
ptr->keys[pos] = newKey;
ptr->p[pos+1] = newPtr;
++ptr->n; /*incrementing the number of keys in node*/
        return Success;
}/*End of if */
/*If keys in nodes are maximum and position of node to be inserted is
last*/
if (pos == M - 1)
{
lastKey = newKey;
lastPtr = newPtr;
}
else /*If keys in node are maximum and position of node to be inserted
is not last*/
{
lastKey = ptr->keys[M-2];
lastPtr = ptr->p[M-1];
for (i=M-2; i>pos; i--)
{
ptr->keys[i] = ptr->keys[i-1];
ptr->p[i+1] = ptr->p[i];
}
ptr->keys[pos] = newKey;
ptr->p[pos+1] = newPtr;
}
splitPos = (M - 1)/2;
(*upKey) = ptr->keys[splitPos];

(*newnode)=malloc(sizeof(struct node));/*Right node after split*/
ptr->n = splitPos; /*No. of keys for left splitted node*/
(*newnode)->n = M-1-splitPos;/*No. of keys for right splitted node*/
for (i=0; i < (*newnode)->n; i++)
{
(*newnode)->p[i] = ptr->p[i + splitPos + 1];
if(i < (*newnode)->n - 1)
(*newnode)->keys[i] = ptr->keys[i + splitPos + 1];
else
(*newnode)->keys[i] = lastKey;
}
```

```
(*newnode)->p[(*newnode)->n] = lastPtr;
return InsertIt;
}/*End of ins()*/

void display(struct node *ptr, int blanks)
{
if (ptr)
{
int i;
for(i=1;i<=blanks;i++)
printf(" ");
for (i=0; i < ptr->n; i++)
printf("%d ",ptr->keys[i]);
printf("\n");
for (i=0; i <= ptr->n; i++)
display(ptr->p[i], blanks+10);
}/*End of if*/
}/*End of display()*/

void search(int key)
{
int pos, i, n;
struct node *ptr = root;
printf("Search path:\n");
while (ptr)
{
n = ptr->n;
for (i=0; i < ptr->n; i++)
printf(" %d",ptr->keys[i]);
printf("\n");
pos = searchPos(key, ptr->keys, n);
if (pos < n && key == ptr->keys[pos])
{
printf("Key %d found in position %d of last dispalyed node\n",key,i);
return;
}
ptr = ptr->p[pos];
}
printf("Key %d is not available\n",key);
}/*End of search()*/

int searchPos(int key, int *key_arr, int n)
{
int pos=0;
while (pos < n && key > key_arr[pos])
pos++;
return pos;
}/*End of searchPos()*/
```

HEAP SORT

```
#include<stdio.h>
int p(int);
int left(int);
int right(int);
void heapify(int[],int,int);
void buildheap(int[],int);
```

```
void heapsort(int[],int);
void main()
  {
     int x[20],n,i;
     printf("enter the no. of elements to b sorted");
     scanf("%d",&n);
     printf("enter the elements ");
     for(i=0;i<n;i++)
     scanf("%d",&x[i]);
     heapsort(x,n);
     printf("sorted array is");
     for(i=0;i<n;i++)
     printf("%d",x[i]);
  }
  int p(int i)
  {
     return i/2;
  }
  int left(int i)
 {
   return 2*i+1;
  }
  int right(int i)
  {
    return 2*i+2;
  }
  void heapify(int a[],int i,int n)
  {
     int l,r,large,t;
     l=left(i);
     r=right(i);
       if((l<=n-1)&&(a[l]>a[i]))
         large=l;
      else
         large=i;
     if((r<=n-1)&&(a[r]>a[large]))
        large=r;
     if(large!=i)
     {
       t=a[i];
      a[i]=a[large];
      a[large]=t;
      heapify(a,large,n);
     }
 }
void buildheap(int a[],int n)
{
    int i;
   for(i=(n-1)/2;i>=0;i--)
     heapify(a,i,n);
}
void heapsort(int a[],int n)
{
   int i,m,t;
   buildheap(a,n);
   m=n ;
   for(i=n-1;i>=1;i--)
   {
```

```
            t=a[0];
            a[0]=a[i];
            a[i]=t;
            m=m-1;
            heapify(a,0,m);
        }
    }
```

9.6 PRE LAB QUESTIONS

1. what is B –tree
2. What is heap
3. What are the properties of B-tree
4. What is sorting

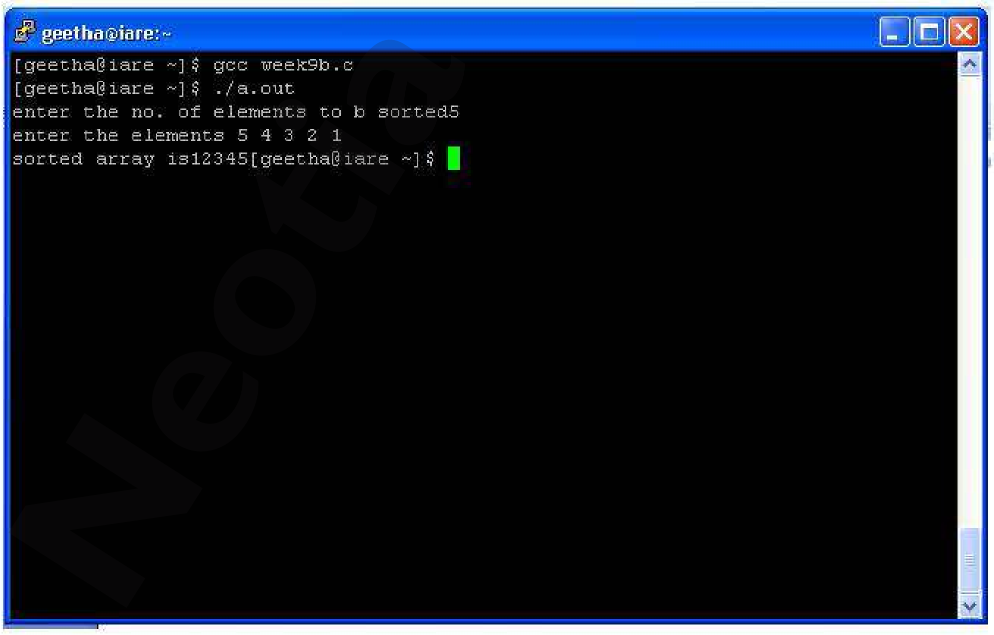
9.7 LAB ASSIGNMENT

1. Apply heap sort on list of elements 14,12,9,8,7,10,18,20,30
2. Construct a B-tree of order 3 with the following elements 10,20,15,3,2,16,21,25,30,40

9.8 POST LAB QUESTIONS

1. What is time complexity of heap sort
2. Write the condition to insert and delete an element into B-tree
3. Is heap sort is stable or not

9.9 INPUT AND OUTPUT



EXPERIMENT 10

10.1 OBJECTIVE

To implement all the functions of a dictionary (ADT) using hashing

10.2 RESOURCE:

Turbo C

10.3 PROGRAM LOGIC

1. Read the key elements from the dictionary
2. Use the hash function to implement dictionary
3. Apply required operation on the dictionary

10.4 PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program

10.5 SOURCE CODE:

DICTIONARY USING HASHING

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
int b;

int hsearch(int key,int d,int *ht,int *empty)
{
        int i=key%(d);
        int j=i;
        int c=0;
        do
        {
            if(empty[j]||(*(ht+j)==key))
            return j;
            c++;
            j=(i+c)%(d);
        }while(j!=i);
        return 0;
}
int search(int key,int d,int *ht,int *empty)
{
      b=hsearch(key,d,ht,empty);
       printf("%d",b);
       if(empty[b]==1)
         return -1;
      else if(b==0)
         return 1;
      else
       return b;
}
/*insertion operation*/
void insert(int key,int d,int *ht,int *empty)
{
      b=hsearch(key,d,ht,empty);
     if(empty[b])
     {
```

```
            empty[b]=0;
             *(ht+b)=key;
          printf("elements is inserted\n");
      }
}
```

/*deletion operation*/

```
void delete(int key,int d,int *ht,int *empty)
{
        int b=hsearch(key,d,ht,empty);
       *(ht+b)=0;
        empty[b]=1;
        printf("element is deleted\n");
}
void display(int d,int *ht,int *empty)
{
     int i;
     printf("hash table elements are\n");
     for(i=0;i<d;i++)
     {
       if(empty[i])
      printf(" 0");
     else
       printf("%5d",*(ht+i));
     }
    printf("\n");
 }
```

/*main program*/

```
void main()
{
       int choice=1;
       int key;
       int d,i,s;
       int *empty,*ht;
       printf("enter the hash table size:");
       scanf("%d",&d);
       ht=(int *)malloc(d *sizeof(int));
     empty=(int *)malloc(d *sizeof(int));
     for(i=0;i<d;i++)
     empty[i]=1;
     while(1)
     {
            printf("\n");
            printf("\n LINEAR PROBING");
            printf("\n 1:insert hash table:");
            printf("\n 2:delete hash table");
            printf("\n 3:search hash table");
            printf("\n 4:display hash table");
            printf("\n 5:exit");
            printf("enter your choice");
            scanf("%d",&choice);
            switch(choice)
            {
                case 1:printf("enter the elemants:");
                         scanf("%d",&key);
                         insert(key,d,ht,empty);
                         break;
                case 2:printf("enter to remove from hash table:");
                         scanf("%d",&key);
```

```
delete(key,d,ht,empty);
break;
case 3:printf("enter the search elements:");
      scanf("%d",&key);
      s=search(key,d,ht,empty);
        if(s==-1||s==0)
         printf("not found\n");
      else
         printf("element found at index %d",hsearch(key,d,ht,empty));
      break;
case 4:display(d,ht,empty);
         break;
case 5:exit(0);
}
}return;
}
```

10.6 PRE LAB QUESTIONS

1. what is dictionary
2. What is hashing
3. List types of hash functions
4. Define linear probing
5. What is quadratic probing

10.7 LAB ASSIGNMENT

1. Use quadratic probing to fill the Hash table of size 11. Data elements are 23,0,52,61,78,33,100,8,90,10,14.
2. Analyze input (371, 323, 173, 199, 344, 679, 989) and hash function h(x)=x mod 10, Show the result Separate Chaining, linear probing

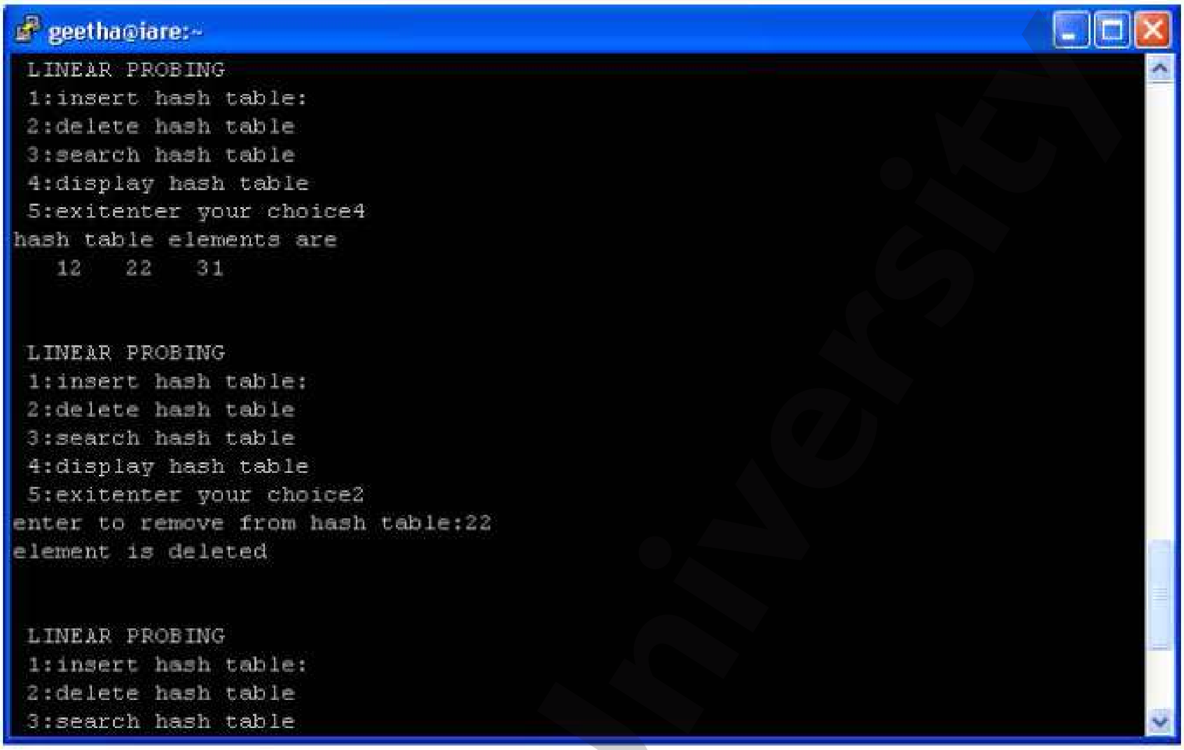
10.8 POST LAB QUESTIONS

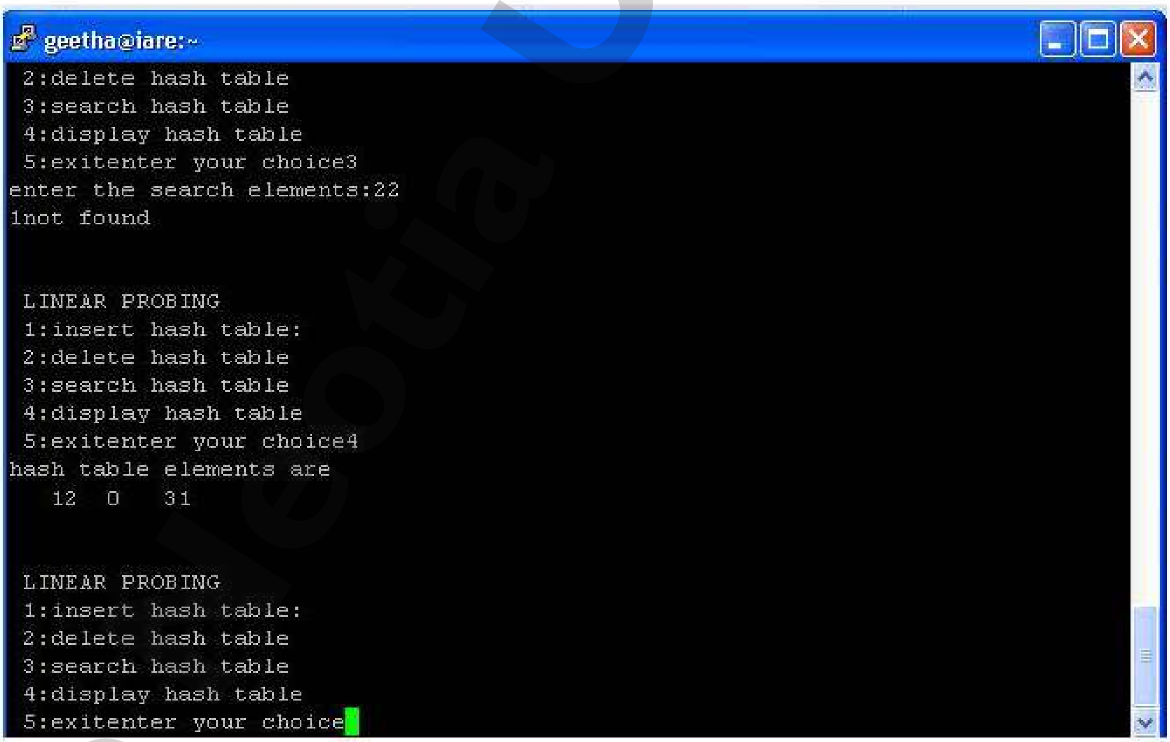
1. List the application of hashing
2. Explain the condition to insert element into hash table
3. What is double hashing

10.9 INPUT AND OUTPUT

```
geetha@iare:~
[geetha@iare ~]$ gcc week9.c
[geetha@iare ~]$ ./a.out
enter the hash table size:3


 LINEAR PROBING
 1:insert hash table:
 2:delete hash table
 3:search hash table
 4:display hash table
 5:exitenter your choice1
enter the elemants:12
elements is inserted


 LINEAR PROBING
 1:insert hash table:
 2:delete hash table
 3:search hash table
 4:display hash table
 5:exitenter your choice1
enter the elemants:22
elements is inserted
```

```
geetha@iare:~
 2:delete hash table
 3:search hash table
 4:display hash table
 5:exitenter your choice1
enter the elemants:22
elements is inserted


 LINEAR PROBING
 1:insert hash table:
 2:delete hash table
 3:search hash table
 4:display hash table
 5:exitenter your choice1
enter the elemants:31
elements is inserted


 LINEAR PROBING
 1:insert hash table:
 2:delete hash table
 3:search hash table
 4:display hash table
 5:exitenter your choice
```


geetha@iare:~
LINEAR PROBING
1:insert hash table:
2:delete hash table
3:search hash table
4:display hash table
5:exitenter your choice4
hash table elements are
12 22 31
LINEAR PROBING
1:insert hash table:
2:delete hash table
3:search hash table
4:display hash table
5:exitenter your choice2
enter to remove from hash table:22
element is deleted
LINEAR PROBING
1:insert hash table:
2:delete hash table
3:search hash table


geetha@iare:~
2:delete hash table
3:search hash table
4:display hash table
5:exitenter your choice3
enter the search elements:22
1not found
LINEAR PROBING
1:insert hash table:
2:delete hash table
3:search hash table
4:display hash table
5:exitenter your choice4
hash table elements are
12 0 31
LINEAR PROBING
1:insert hash table:
2:delete hash table
3:search hash table
4:display hash table
5:exitenter your choice

EXPERIMENT 11

11.1 OBJECTIVE

To implementing Knuth-Morris- Pratt pattern matching algorithm

11.2 RESOURCE:

Turbo C

11.3 PROGRAM LOGIC

1. Read the pattern and text
2. Compute failure function
3. Apply the KMP algorithm

11.4 PROCEDURE

Go to debug -> run or press CTRL + F9 to run the program

11.5 SOURCE CODE

Knuth-Morris- Pratt pattern matching algorithm

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

void computefailure(char *pat, int M, int *f);

void KMPSearch(char *pat, char *txt) //to implement kmp search
{
    int M = strlen(pat);//length of pattern
    int N = strlen(txt);//length of text

    int *f = (int *)malloc(sizeof(int)*M); //dynamic allocation
    int j = 0; // index for pat[]

    computefailure(pat, M, f);

    int i = 0; // index for txt[]
    while(i < N)
    {
     if(pat[j] == txt[i])
     {
      j++;
      i++;
     }
     if (j == M)
     {
      printf("Found pattern at index %d \n", i-j);
      j = f[j-1];
     }
       else if(pat[j] != txt[i])
    {
         if(j != 0)
     j = f[j-1];
    else
     i = i+1;
    }
```

```
    }
    free(f); }

void computefailure (char *pat, int M, int *f) //compute the failure function
{
        int len = 0;
        int i;

        f[0] = 0; // f[0] is always 0
        i = 1;

        while(i < M)
        {
                if(pat[i] == pat[len])
                {
                  len++;
                  f[i] = len;
                  i++;
                }
                else // (pat[i] != pat[len])
                {
                  if( len != 0 )
                  {
                      len = f[len-1];
                  }
                  else // if (len == 0)
                  {
                    f[i] = 0;
                    i++;
                  }
                }
        }
    }

int main()
{
    int match;
      printf("\nEnter the Text: ");
      gets(text); //reading the text
      printf("\nEnter the Pattern: ");
      gets(pattern); //reading the pattern
      m=strlen(text);
      n=strlen(pattern);
      match=KMPSearch(pat, txt);

      if(match>=0)
      {
              printf("\nMatch found at position %d\n\n",match);
      }
      else
      {
         printf("\nNo Match found!!!\n\n");
      }
      return 0;
}
```

11.6 PRE LAB QUESTIONS

1. what is pattern matching
2. List the various pattern matching algorithms
3. What is failure function

11.7 LAB ASSIGNMENT

1. Apply KMP algorithm on pattern "abacab" and text "abacaabaccabacabaabb"
2. Apply KMP algorithm on pattern "abaa" and text "abbbaababaab"

11.8 POST LAB QUESTIONS

1. Which pattern matching algorithm is better
2. Write the significance of Knuth-Morris- Pratt pattern matching algorithm
3. List the applications of pattern matching algorithms

11. 9 INPUT AND OUTPUT

EXPERIMENT 12

A: Write C programs for implementing the following graph traversal algorithm for Depth first traversal

12.1 OBJECTIVE

To traverse graph

12.2 RESOURCE:

Turbo C

12.3 PROGRAM LOGIC

1. Take the graph as a input
2. Start at some vertex and traverse it using DFS
3. Apply the above procedure for all nodes

12.4 PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program

12.5 SOURCE CODE:

DFS

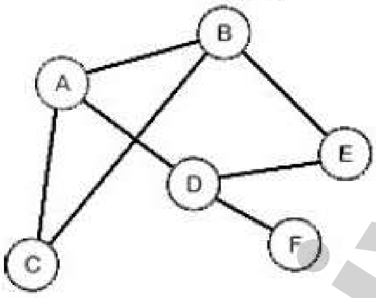
```
#include <stdio.h>
void dfs(int);
int g[10][10],visited[10],n,vertex[10];
void main()
{
   int i,j;
   printf("enter number of vertices:");
   scanf("%d",&n);
   printf("enter the val of vertex:");
   for(i=0;i<n;i++)
         scanf("%d",&vertex[i]);
  printf("\n enter adjecency matrix of the graph:");
  for(i=0;i<n;i++)
         for(j=0;j<n;j++)
         scanf("%d",&g[i][j]);
 for(i=0;i<n;i++)
  visited[i]=0;
  dfs(0);
}
void dfs(int i)
{
  int j;
  printf("%d",vertex[i]);
 visited[i]=1;      for(j=0;j<n;j++)
 if(!visited[j]&&g[i][j]==1)
   dfs(j);
}
```

12.6 PRE LAB QUESTIONS

1. What is graph
2. List various way of representations of graph
3. How many graph traversal algorithms are there

12.7 LAB ASSIGNMENT

1. Find DFS traversal of the following graph



2. Deduce the time complexity of DFS algorithm

12.8 POST LAB QUESTIONS

1. Applications of graph traversals
2. Define minimum spanning tree
3. What is the time complexity of DFS

12.9 INPUT AND OUT

```
geetha@iare:~
[geetha@iare ~]$ gcc dfs.c
[geetha@iare ~]$ ./a.out
enter number of vertices:4
enter the val of vertex:1 2 3 4

 enter adjecency matrix of the graph:0 1 1 1
1 0 0 1
1 0 0 1
1 1 1 0
1243[geetha@iare ~]$
```

EXPERIMENT 13

1.1 OBJECTIVE

Write a C Program to check whether two given lists are containing the same data.

1.2 SOURCE CODE

```
#include <stdio.h>
#include <stdlib.h>
struct node
{
    int num;
    struct node *next;
};

void feedmember(struct node **);
int compare (struct node *, struct node *);
void release(struct node **);

int main() {
    struct node *p = NULL;
    struct node *q = NULL;
    int result;

    printf("Enter data into first list\n");
    feedmember(&p);
    printf("Enter data into second list\n");
    feedmember(&q);
    result = compare(p, q);
    if (result == 1)    {
        printf("The 2 list are equal.\n");
    }
    else    {
        printf("The 2 lists are unequal.\n");
    }
    release (&p);
    release (&q);

    return 0;
}

int compare (struct node *p, struct node *q) {
    while (p != NULL && q != NULL)
    {
        if (p->num != q-> num)        {
            return 0;
        }
        else
        {
            p = p->next;
            q = q->next;
        }
    }
    if (p != NULL || q != NULL)     {
        return 0;
    }
```

```
    else    {
        return 1;
    }
}

void feedmember (struct node **head)
{
    int c, ch;
    struct node *temp;

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

void release (struct node **head) {
    struct node *temp = *head;

    while ((*head) != NULL)
    {
        (*head) = (*head)->next;
        free(temp);
        temp = *head;
    }
}
```

INPUT/ OUTPUT

```
Enter data into first list
Enter number: 12
Do you wish to continue [1/0]: 1
Enter number: 3
Do you wish to continue [1/0]: 1
Enter number: 28
Do you wish to continue [1/0]: 1
Enter number: 9
Do you wish to continue [1/0]: 0

Enter data into second list
Enter number: 12
Do you wish to continue [1/0]: 1
Enter number: 3
Do you wish to continue [1/0]: 1
Enter number: 28
Do you wish to continue [1/0]: 1
Enter number: 9
Do you wish to continue [1/0]: 0

The 2 list are equal.
```

EXPERIMENT 14

2.1 OBJECTIVE

Write a C program to find the largest element in a given doubly linked list.

2.2 SOURCE CODE

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

struct node
{
    int num;
    struct node *next;
    struct node *prev;
};

void create(struct node **);
int max(struct node *);
void release(struct node **);

int main()
{
    struct node *p = NULL;
    int n;

    printf("Enter data into the list\n");
    create(&p);
    n = max(p);
    printf("The maximum number entered in the list is %d.\n", n);
    release (&p);

    return 0;
}

int max(struct node *head)
{
    struct node *max, *q;

    q = max = head;
    while (q != NULL)
    {
        if (q->num > max->num)
        {
            max = q;
        }
        q = q->next;
    }

    return (max->num);
}

void create(struct node **head)
{
    int c, ch;
    struct node *temp, *rear;
```

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

void release(struct node **head)
{
    struct node *temp = *head;
    *head = (*head)->next;
    while ((*head) != NULL)
    {
        free(temp);
        temp = *head;
        (*head) = (*head)->next;
    }
}
```

INPUT/ OUTPUT:

```
Enter data into the list
Enter number: 12
Do you wish to continue [1/0]: 1
Enter number: 7
Do you wish to continue [1/0]: 1
Enter number: 23
Do you wish to continue [1/0]: 1
Enter number: 4
Do you wish to continue [1/0]: 1
Enter number: 1
Do you wish to continue [1/0]: 1
Enter number: 16
Do you wish to continue [1/0]: 0

The maximum number entered in the list is 23.
```

EXPERIMENT 15

3.1 OBJECTIVE

Write a C program to reverse the elements in the stack using recursion.

3.2 SOURCE CODE

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

struct node
{
    int a;
    struct node *next;
};

void generate(struct node **);
void display(struct node *);
void stack_reverse(struct node **, struct node **);
void delete(struct node **);

int main()
{
    struct node *head = NULL;

    generate(&head);
    printf("\nThe sequence of contents in stack\n");
    display(head);
    printf("\nInversing the contents of the stack\n");
    if (head != NULL)
    {
        stack_reverse(&head, &(head->next));
    }
    printf("\nThe contents in stack after reversal\n");
    display(head);
    delete(&head);

    return 0;
}

void stack_reverse(struct node **head, struct node **head_next)
{
    struct node *temp;

    if (*head_next != NULL)
    {
         temp = (*head_next)->next;
        (*head_next)->next = (*head);
        *head = *head_next;
        *head_next = temp;
        stack_reverse(head, head_next);
    }
}

void display(struct node *head)
{
```

```
    if (head != NULL)
    {
        printf("%d ", head->a);
        display(head->next);
    }
}

void generate(struct node **head)
{
    int num, i;
    struct node *temp;

    printf("Enter length of list: ");
    scanf("%d", &num);
    for (i = num; i > 0; i--)
    {
        temp = (struct node *)malloc(sizeof(struct node));
        temp->a = i;
        if (*head == NULL)
        {
            *head = temp;
            (*head)->next = NULL;
        }
        else
        {
            temp->next = *head;
            *head = temp;
        }
    }
}

void delete(struct node **head)
{
    struct node *temp;
    while (*head != NULL)
    {
        temp = *head;
        *head = (*head)->next;
        free(temp);
    }
}
```

INPUT/OUTPUT:

Enter length of list: 10

The sequence of contents in stack
1 2 3 4 5 6 7 8 9 10

Reversing the contents of the stack

The contents in stack after reversal
10 9 8 7 6 5 4 3 2 1

EXPERIMENT 16

4.1 OBJECTIVE

Write a C program to implement stack using linked list.

4.2 SOURCE CODE

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

struct node
{
   int info;
   struct node *ptr;
}*top,*top1,*temp;

int topelement();
void push(int data);
void pop();
void empty();
void display();
void destroy();
void stack_count();
void create();

int count = 0;

void main()
{
   int no, ch, e;

   printf("\n 1 - Push");
   printf("\n 2 - Pop");
   printf("\n 3 - Top");
   printf("\n 4 - Empty");
   printf("\n 5 - Exit");
   printf("\n 6 - Dipslay");
   printf("\n 7 - Stack Count");
   printf("\n 8 - Destroy stack");

   create();

   while (1)
   {
      printf("\n Enter choice : ");
      scanf("%d", &ch);

      switch (ch)
      {
      case 1:
         printf("Enter data : ");
         scanf("%d", &no);
         push(no);
         break;
      case 2:
         pop();
         break;
```

```
        case 3:
            if (top == NULL)
                printf("No elements in stack");
            else
            {
                e = topelement();
                printf("\n Top element : %d", e);
            }
            break;
        case 4:
            empty();
            break;
        case 5:
            exit(0);
        case 6:
            display();
            break;
        case 7:
            stack_count();
            break;
        case 8:
            destroy();
            break;
        default :
            printf(" Wrong choice, Please enter correct choice ");
            break;
        }
    }
}

/* Create empty stack */
void create()
{
    top = NULL;
}

/* Count stack elements */
void stack_count()
{
    printf("\n No. of elements in stack : %d", count);
}

/* Push data into stack */
void push(int data)
{
    if (top == NULL)
    {
        top =(struct node *)malloc(1*sizeof(struct node));
        top->ptr = NULL;
        top->info = data;
    }
    else
    {
        temp =(struct node *)malloc(1*sizeof(struct node));
        temp->ptr = top;
        temp->info = data;
        top = temp;
    }
```

```
    count++;
}

/* Display stack elements */
void display()
{
    top1 = top;

    if (top1 == NULL)
    {
        printf("Stack is empty");
        return;
    }

    while (top1 != NULL)
    {
        printf("%d ", top1->info);
        top1 = top1->ptr;
    }
 }

/* Pop Operation on stack */
void pop()
{
    top1 = top;

    if (top1 == NULL)
    {
        printf("\n Error : Trying to pop from empty stack");
        return;
    }
    else
        top1 = top1->ptr;
    printf("\n Popped value : %d", top->info);
    free(top);
    top = top1;
    count--;
}

/* Return top element */
int topelement()
{
    return(top->info);
}

/* Check if stack is empty or not */
void empty()
{
    if (top == NULL)
        printf("\n Stack is empty");
    else
        printf("\n Stack is not empty with %d elements", count);
}

/* Destroy entire stack */
void destroy()
{
    top1 = top;
```

```
    while (top1 != NULL)
    {
        top1 = top->ptr;
        free(top);
        top = top1;
        top1 = top1->ptr;
    }
    free(top1);
    top = NULL;

    printf("\n All stack elements destroyed");
    count = 0;
}
```

INPUT/OUTPUT:

```
1 - Push
2 - Pop
3 - Top
4 - Empty
5 - Exit
6 - Dipslay
7 - Stack Count
8 - Destroy stack
Enter choice : 1
Enter data : 56

Enter choice : 1
Enter data : 80

Enter choice : 2

Popped value : 80
Enter choice : 3

Top element : 56
Enter choice : 1
Enter data : 78

Enter choice : 1
Enter data : 90

Enter choice : 6
90 78 56
Enter choice : 7

No. of elements in stack : 3
Enter choice : 8

All stack elements destroyed
Enter choice : 4

Stack is empty
Enter choice : 5
```

EXPERIMENT 17

5.1 OBJECTIVE

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

5.2 SOURCE CODE

```
#include < stdio.h >
#include < conio.h >
#include < alloc.h >
#define new_node (struct node*)malloc(sizeof (struct node))

struct node
{
        int data;
        struct node *lchild;
        struct node *rchild;
};

struct node *create_bin_rec();
void print_bin_pre_rec(struct node *t);
void cnt_nodes(struct node *t, int *l, int *nl);

void main()
{
        struct node *root;
        int leaf,nonleaf;
        clrscr();
        printf("\nCreate a binary tree \n");
        root = create_bin_rec();
        printf("\n Binary tree is ");
        print_bin_pre_rec(root);
        leaf = nonleaf = 0;
        cnt_nodes(root,&leaf,&nonleaf);
        printf("\n Total no. of leaf nodes are : %d ",leaf);
        printf("\n Total no. of nonleaf nodes are : %d ",nonleaf);
        printf("\n Total no. of nodes are : %d ", (leaf+nonleaf));

} // main

struct node *create_bin_rec()
{
        int  data;
        struct node *t;
        printf("\nData ( -1 to exit ) : ");
        scanf("%d",&data);
        if( data == -1)
                return(NULL);
        else
        {
                t = new_node;
                t->data = data;
                t->lchild =create_bin_rec();
                t->rchild =create_bin_rec();
                return(t);
        } //else
```

```
} // create

void print_bin_pre_rec(struct node *t)
{
        if( t != NULL)
        {
                printf("%4d",t->data);
                print_bin_pre_rec(t->lchild);
                print_bin_pre_rec(t->rchild);
        } // if
} // print bin pre rec

void cnt_nodes(struct node *t, int *l, int *nl)
{
        if( t != NULL)
        {
                if( t->lchild == NULL && t->rchild == NULL)
                        (*l)++;
                else
                        (*nl)++;
                        cnt_nodes(t->lchild,l,nl);
                        cnt_nodes(t->rchild,l,nl);
        } // if
} // cnt nodes
```

INPUT OUTPUT

```
Create binary tree
Data (-1 to exit) 10
Data (-1 to exit) 20
Data (-1 to exit)  -1

Binary tree is 10 20
Total no. of leaf nodes are 1
Total no. of non leaf nodes are 1
Total no. of nodes are 2
```

EXPERIMENT 18

6.1 OBJECTIVE

Write a C program to sort an array of integers in ascending order using radix sort.

6.2 SOURCE CODE

```
#include <stdio.h>
int min = 0, count = 0, array[100] = {0}, array1[100] = {0};

void main()
{
   int k, i, j, temp, t, n;

   printf("Enter size of array :");
   scanf("%d", &count);
   printf("Enter elements into array :");
   for (i = 0; i < count; i++)
   {
      scanf("%d", &array[i]);
      array1[i] = array[i];
   }
   for (k = 0; k < 3; k++)
   {
      for (i = 0; i < count; i++)
      {
         min = array[i] % 10;        /* To find minimum lsd */
         t = i;
         for (j = i + 1; j < count; j++)
         {
            if (min > (array[j] % 10))
            {
               min = array[j] % 10;
               t = j;
            }
         }
         temp = array1[t];
         array1[t] = array1[i];
         array1[i] = temp;
         temp = array[t];
         array[t] = array[i];
         array[i] = temp;

      }
      for (j = 0; j < count; j++)        /*to find MSB */
         array[j] = array[j] / 10;
   }
   printf("Sorted Array (lSdradix sort) : ");
   for (i = 0; i < count; i++)
      printf("%d ", array1[i]);
}
```

INPUT/ OUTPUT:

/* Average Case */

Enter size of array :7

Enter elements into array :170
45
90
75
802
24
2
Sorted Array (ladradix sort) : 2 24 45 75 90 170 802

/*Best case */
Enter size of array :7
Enter elements into array :22
64
121
78
159
206
348
Sorted Array (ladradix sort) : 22 64 78 159 121 206 348

/* Worst case */
Enter size of array :7
Enter elements into array :985
27
64
129
345
325
091
Sorted Array (ladradix sort) : 27 64 91 129 325 345 985

EXPERIMENT 19

7.1 OBJECTIVE

Write a C program to sort a given list of strings.

7.2 SOURCE CODE

```
#include<stdio.h>
#include<string.h>
#include<stdlib.h>
int main() {
char *str[5], *temp;
 int i, j, n;
 printf("\nHow many names do you want to have?");
 scanf("%d", &n);
 for (i = 0; i < n; i++) {
      printf("\nEnter the name %d: ", i);
      flushall();
      gets(str[i]);
}
for (i = 0; i < n; i++) {
     for (j = 0; j < n - 1; j++) {
        if (strcmp(str[j], str[j + 1]) > 0) {
            strcpy(temp, str[j]);
            strcpy(str[j], str[j + 1]);
            strcpy(str[j + 1], temp);
} } }
printf("\nSorted List : ");
for (i = 0; i < n; i++)
      puts(str[i]);
   return (0);
}
```

INPUT /OUTPUT:

Enter any strings :

pri

pra

pru

pry

prn

Strings in order are :

pra

pri

prn

pru

pry