VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

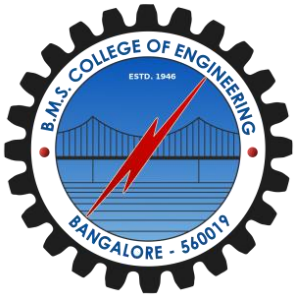
LAB REPORT
on

DATA STRUCTURES

Submitted by:

Sanchay Agrawal (1BM21CS186)

in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING



B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
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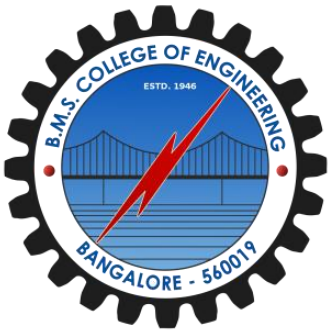

CERTIFICATE

This is to certify that the Lab work entitled "**DATA STRUCTURES**" carried out by **Sanchay Agrawal (1BM21CS186),** who is bonafide student of **B. M. S. College of Engineering.** It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2022-23. The Lab report has been approved as it satisfies the academic requirements in respect of **Data structures Lab - (22CS3PCDST)** work prescribed for the said degree.

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1. Course Outcomes:

CO1: Apply the concept of linear and nonlinear data structures.

CO2: Analyse data structure operations for a given problem.

CO3: Design and develop solutions using the operations of linear and nonlinear data structure for a given specification.

CO4: Conduct practical experiments for demonstrating the operations of different data structures.

2. Experiments:

2.1 Experiment: 1

2.1.1 Question:

Write a program to simulate the working of stack using an array with the following:

a) Push
b) Pop
c) Display

The program should print appropriate messages for stack overflow, stack underflow.

2.1.2 Code:

```
#include<stdio.h>

int stack[100],choice,n,top,x,i;
void push(void);
void pop(void);
void display(void);
int main()
{
   top=-1;
   printf("\nEnter the size of STACK");
   scanf("%d",&n);
   printf("\n1.Push\n2.Pop\n3.Display\n4.Exit");

   do
   {
      printf("\nEnter the Choice:");
      scanf("%d",&choice);
      switch(choice)
      {
         case 1: push();
                 break;

         case 2: pop();
```

```
                break;

        case 3: display();
                break;

        case 4: printf("\nExit");
                break;

        default: printf ("\nEnter a Valid Choice");
      }
   }
   while(choice!=4);
   return 0;
}

void push()
{
   if(top>=n-1)
   {
      printf("\nSTACK overflow");
   }

   else
   {
      printf("\nEnter a value to be pushed:");
      scanf("%d",&x);
      top++;
      stack[top]=x;
   }
}
void pop()
{
   if(top<=-1)
   {
      printf("\n\t Stack underflow");
   }

   else
   {
      printf("\n\t The popped elements is %d",stack[top]);
      top--;
   }
}
void display()
{
   if(top>=0)
```

```
    {
       printf("\n The elements in STACK \n");
       for(i=top; i>=0; i--)
          printf("\n%d",stack[i]);
       printf("\n Enter Next Choice");
    }
    else
    {
       printf("\n The STACK is empty");
    }

}
```

2.1.3 Output:

//Inserting Elements in Stack

```
Enter the size of STACK: 4

1.Push
2.Pop
3.Display
4.Exit

Enter the Choice: 1

Enter a value to be pushed: 10

Enter the Choice: 1

Enter a value to be pushed: 20

Enter the Choice: 1

Enter a value to be pushed: 30

Enter the Choice: 1

Enter a value to be pushed: 40

Enter the Choice: 1

STACK overflow
```

//Display Elements of Stack

```
Enter the Choice: 3

 The elements in STACK:

40
30
20
10
```

//Deleting Elements from Stack

```
 Enter Next Choice:
Enter the Choice: 2

        The popped element is: 40
Enter the Choice: 2

        The popped element is: 30
Enter the Choice: 2

        The popped element is: 20
Enter the Choice: 2

        The popped element is: 10
Enter the Choice: 2

        Stack underflow
Enter the Choice: 3

 The STACK is empty
```

2.2 Experiment: 2

2.2.1 Question:

WAP to convert a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and the binary operators:

+ (plus), - (minus), * (multiply) and / (divide)

2.2.2 Code:

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

#define SIZE 100

char stack[SIZE];
int top = -1;

void push(char item)
{
   if(top >= SIZE-1)
   {
      printf("\nSTACK Overflow.");
   }

   else
   {
      top = top+1;
      stack[top] = item;
   }
}

char pop()
{
   char item ;

   if(top <0)
   {
      printf("STACK Underflow");
      getchar();
      exit(1);
   }

   else
   {
      item = stack[top];
```

```
        top = top-1;
        return(item);
    }
}

int is_operator(char symbol)
{
    if(symbol == '*' || symbol == '/' || symbol == '+' || symbol =='-')
    {
        return 1;
    }

    else
    {
        return 0;
    }
}

int precedence(char symbol)
{
    if(symbol == '*' || symbol == '/')
    {
        return(2);
    }

    else if(symbol == '+' || symbol == '-')
    {
        return(1);
    }

    else
    {
        return(0);
    }
}

void InfixToPostfix(char infix_exp[], char postfix_exp[])
{
    int i, j;
    char item;
    char x;

    push('(');
    strcat(infix_exp,")");
```

```
i=0;
j=0;
item=infix_exp[i];

while(item != '\0')
{
   if(item == '(')
   {
      push(item);
   }
   else if( isdigit(item) || isalpha(item))
   {
      postfix_exp[j] = item;
      j++;
   }
   else if(is_operator(item) == 1)
   {
      x=pop();
      while(is_operator(x) == 1 && precedence(x)>= precedence(item))
      {
         postfix_exp[j] = x;
         j++;
         x = pop();
      }
      push(x);
      push(item);
   }

   else if(item == ')')
   {
      x = pop();
      while(x != '(')
      {
         postfix_exp[j] = x;
         j++;
         x = pop();
      }
   }
   else
   {
      printf("\nInvalid infix Expression.\n");
      getchar();
      exit(1);
   }

i++;
```

```
    item = infix_exp[i];
    }

    if(top>0)
    {
       printf("\nInvalid infix Expression.\n");
       getchar();
       exit(1);
    }

    postfix_exp[j] = '\0';
}

int main()
{
    char infix[SIZE], postfix[SIZE];

    printf("Enter Infix expression : \n");
    gets(infix);

    InfixToPostfix(infix,postfix);
    printf("Postfix Expression: ");
    puts(postfix);

    return 0;
}
```

2.2.3 Output:

```
Enter Infix expression :
((A+B)-C*(D/E))+F
Postfix Expression: AB+CDE/*-F+
```

```
Enter Infix expression :
(A+(B*C))+D
Postfix Expression: ABC*+D+
```

2.3 Experiment: 3

2.3.1 Question:

WAP to simulate the working of a queue of integers using an array. Provide the following operations:

a) Insert
b) Delete
c) Display

The program should print appropriate messages for queue empty and queue overflow conditions.

2.3.2 Code:

```
#include<stdio.h>
#include<stdlib.h>
#define SIZE 5

void enqueue(int);
void dequeue();
void display();

int queue[SIZE], front = -1, rear = -1;

void main()
{
  int value, choice;
   printf(“Queue Operations: ”);
   printf("1. Insert\n2. Delete\n3. Display\n4. Exit");

  while(1)
   {
    printf("\nEnter your choice: ");
    scanf("%d",&choice);

    switch(choice)
    {
     case 1: printf("Enter the value to be insert: ");
             scanf("%d",&value);
             enqueue(value);
             break;

     case 2: dequeue();
             break;

     case 3: display();
             break;
```

```
        case 4: exit(0);

        default: printf("\nInvalid Input");
      }
   }
}

void enqueue(int value)
{
   if(rear == SIZE-1)
      printf("\nQueue is Full!");

   else
    {
      if(front == -1)
      front = 0;
      rear++;
      queue[rear] = value;
   }
}

void dequeue()
{
      if(front == rear)
      printf("\nQueue is Empty!");

      else
      {
         printf("\nDeleted : %d", queue[front]);
         front++;
      }
}

void display()
{
   if(rear == -1)
      printf("\nQueue is Empty!!!");

   else
    {
      int i;
      printf("\nQueue elements are:\n");
      for(i=front; i<=rear; i++)
           printf("%d\n",queue[i]);
    }
}
```

2.3.3 Output:

//Insert in Queue

```
Queue Operations
1. Insert
2. Delete
3. Display
4. Exit

Enter your choice: 1
Enter the value to be insert: 10

Enter your choice: 1
Enter the value to be insert: 20

Enter your choice: 1
Enter the value to be insert: 30

Enter your choice: 1
Enter the value to be insert: 40
```

//Display Elements in Queue

```
Queue elements are:
10
20
30
40
```

//Deleting From Queue

```
Enter your choice: 2

Deleted : 10
Enter your choice: 2

Deleted : 20
Enter your choice: 2

Deleted : 30
Enter your choice: 2

Queue is Empty!
Enter your choice: 3

Queue elements are:
40

Enter your choice: 2

Queue is Empty!
```

2.4 Experiment: 4

2.4.1 Question:

WAP to simulate the working of a circular queue of integers using an array. Provide the following operations:

a) Insert
b) Delete
c) Display

The program should print appropriate messages for queue empty and queue overflow conditions.

2.4.2 Code:

```
#include<stdio.h>
# define MAX 5

int cqueue_arr[MAX];
int front = -1;
int rear = -1;

void insert(int item) {
   if((front == 0 && rear == MAX-1) || (front == rear+1))
   {
      printf("\nOVERFLOW\n");
      return;
   }

   if(front == -1)
      {
         front = 0;
         rear = 0;
      }

   else
      {
         if(rear == MAX-1)
         rear = 0;

         else
         rear = rear+1;
      }

   cqueue_arr[rear] = item ;
}

void delete() {
   if(front == -1)
```

```
        {
            printf("\nUNDERFLOW\n");
            return ;
        }

    printf("\nElement deleted from queue is : %d\n",cqueue_arr[front]);

    if(front == rear)
        {
            front = -1;
            rear=-1;
        }
    else
        {
            if(front == MAX-1)
            front = 0;

            else
            front = front+1;
        }
}

void display()
{
        if(front == -1)
        {
            printf("\nQueue is empty\n");
            return;
        }

        else
        {
            int i;
            printf("\nQueue elements are:\n");

            for(i=front; i<=rear; i++)
            printf("%d\n",cqueue_arr[i]);
        }
}

int main()
{
    int choice,item;
    printf("Circular Queue Operations: \n");
            printf("1.Insert\n");
            printf("2.Delete\n");
```

```
        printf("3.Display\n");
        printf("4.Exit\n");
    do
      {
        printf("\nEnter your choice : ");
        scanf("%d",&choice);

    switch(choice)
      {
        case 1: printf("\nInput the element for insertion in queue : ");
                scanf("%d", &item);
                insert(item);
                break;

        case 2: delete();
                break;

        case 3: display();
                break;

        case 4: break;

        default: printf("Wrong choice\n");
      }

      }

    while(choice!=4);
    return 0;
}
```

Output:

//Inserting Elements in Circular Queue

```
Circular Queue Operations:
1.Insert
2.Delete
3.Display
4.Exit

Enter your choice : 1

Input the element for insertion in queue : 10

Enter your choice : 1

Input the element for insertion in queue : 20

Enter your choice : 1

Input the element for insertion in queue : 30

Enter your choice : 1

Input the element for insertion in queue : 40

Enter your choice : 1

Input the element for insertion in queue : 50

Enter your choice : 1

Input the element for insertion in queue : 60

OVERFLOW
```

//Display Elements in Circular Queue

```
Enter your choice : 3

Queue elements are:
10
20
30
40
50
```

//Deleting Elements from Circular Queue

```
Enter your choice : 2

Element deleted from queue is : 10

Enter your choice : 2

Element deleted from queue is : 20

Enter your choice : 2

Element deleted from queue is : 30

Enter your choice : 2

Element deleted from queue is : 40

Enter your choice : 2

Element deleted from queue is : 50

Enter your choice : 2

UNDERFLOW

Enter your choice : 3

Queue is empty
```

2.5 Experiment: 5

2.5.1 Question:

WAP to Implement Singly Linked List with following operations:

a) Create a linked list.
b) Insertion of a node at first position, at any position and at end of list.
c) Display the contents of the linked list.

2.5.2 Code:

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

struct node{
   int info;
   struct node* link;
};

struct node* start = NULL;

void createList()
{
   if (start == NULL) {
      int n;
      printf("\nEnter the number of nodes: ");
      scanf("%d", &n);

      if (n != 0) {
         int data;
         struct node* newnode;
         struct node* temp;
         newnode = malloc(sizeof(struct node));
         start = newnode;
         temp = start;

         printf("\nEnter number to be inserted : ");
         scanf("%d", &data);
         start->info = data;

         for (int i = 0; i <= n; i++) {
            newnode = malloc(sizeof(struct node));
            temp->link = newnode;
            printf("\nEnter number to be inserted : ");
            scanf("%d", &data);
            newnode->info = data;
            temp = temp->link;
         }
```

```
        }
        printf("\nList Created\n");
    }
    else
        printf("\nThe list is already created\n");
}

void traverse()
{
    struct node* temp;

    if (start == NULL)
        printf("\nList is empty\n");

    else
        {
        temp = start;
        while (temp != NULL)
            {
            printf("Element = %d\n", temp->info);
            temp = temp->link;
            }
        }
}

void insertFront()
{
    int data;
    struct node* temp;
    temp = malloc(sizeof(struct node));
    printf("\nEnter number to be inserted : ");
    scanf("%d", &data);
    temp->info = data;

    temp->link = start;
    start = temp;
}

void insertEnd()
{
    int data;
    struct node *temp, *head;
    temp = malloc(sizeof(struct node));

    printf("\nEnter number to be inserted : ");
    scanf("%d", &data);
```

```
    temp->link = 0;
    temp->info = data;
    head = start;
    while (head->link != NULL) {
        head = head->link;
    }
    head->link = temp;
}


void insertPosition()
{
    struct node *temp, *newnode;
    int pos, data, i = 1;
    newnode = malloc(sizeof(struct node));

    printf("\nEnter position and data :");
    scanf("%d %d", &pos, &data);

    temp = start;
    newnode->info = data;
    newnode->link = 0;
    while (i < pos - 1) {
        temp = temp->link;
        i++;
    }
    newnode->link = temp->link;
    temp->link = newnode;
}

int main()
{
    printf("Singly Linked List Insertion and Display Operations");
    printf("\n1. Insert At First Position");
    printf("\n2. Insert At Last Position");
    printf("\n3. Insert At Any Position");
    printf("\n4. Display Elements");
    printf("\n5. Exit");

    while(1){
    int choice;
        printf("\n\nEnter your choice: ");
        scanf("%d", &choice);

        switch (choice)
```

```
        {
        case 1: insertFront();
                break;

        case 2: insertEnd();
                break;

        case 3: insertPosition();
                break;

        case 4: traverse();
                break;

        case 5: exit(1);
                break;

        default: printf("Wrong choice!!!!!!\n");
        }
    }
    return 0;
}
```

2.5.3 Output:

//Inserting Elements in A Singly Linked List

```
Singly Linked List Insertion and Display Operations
1. Insert At First Position
2. Insert At Last Position
3. Insert At Any Position
4. Display Elements
5. Exit

Enter your choice: 1

Enter number to be inserted : 10


Enter your choice: 2

Enter number to be inserted : 50


Enter your choice: 3

Enter position and data :2
20


Enter your choice: 3

Enter position and data :3
30


Enter your choice: 3

Enter position and data :4
40
```

//Display Elements in A Singly Linked List

```
Enter your choice: 4
Element = 10
Element = 20
Element = 30
Element = 40
Element = 50
```

2.6 Experiment: 6

2.6.1 Question:

WAP to Implement Singly Linked List with following operations:

a) Create a linked list.
b) Deletion of first element, specified element and last element in the list.
c) Display the contents of the linked list.

2.6.2 Code:

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

struct node{
   int info;
   struct node* link;
};

struct node* start = NULL;

void createList()
{
   if (start == NULL) {
      int n;
      printf("\nEnter the number of nodes: ");
      scanf("%d", &n);

      if (n != 0) {
         int data;
         struct node* newnode;
         struct node* temp;
         newnode = malloc(sizeof(struct node));
         start = newnode;
         temp = start;

         printf("\nEnter number to be inserted : ");
         scanf("%d", &data);
         start->info = data;

         for (int i = 0; i <= n; i++) {
            newnode = malloc(sizeof(struct node));
            temp->link = newnode;
            printf("\nEnter number to be inserted : ");
            scanf("%d", &data);
            newnode->info = data;
            temp = temp->link;
         }
```

```
        }
        printf("\nList Created\n");
    }
    else
        printf("\nThe list is already created\n");
}

void insertFront()
{
    int data;
    struct node* temp;
    temp = malloc(sizeof(struct node));
    printf("\nEnter number to be inserted : ");
    scanf("%d", &data);
    temp->info = data;

    temp->link = start;
    start = temp;
}

void insertEnd()
{
    int data;
    struct node *temp, *head;
    temp = malloc(sizeof(struct node));

    printf("\nEnter number to be inserted : ");
    scanf("%d", &data);

    temp->link = 0;
    temp->info = data;
    head = start;
    while (head->link != NULL) {
        head = head->link;
    }
    head->link = temp;
}

void insertPosition()
{
    struct node *temp, *newnode;
    int pos, data, i = 1;
    newnode = malloc(sizeof(struct node));

    printf("\nEnter position and data :");
    scanf("%d %d", &pos, &data);
```

```
    temp = start;
    newnode->info = data;
    newnode->link = 0;
    while (i < pos - 1) {
        temp = temp->link;
        i++;
    }
    newnode->link = temp->link;
    temp->link = newnode;
}

void deleteFirst()
{
    struct node* temp;
    if (start == NULL)
        printf("\nList is empty\n");

    else
    {
        temp = start;
        start = start->link;
        free(temp);
    }
}

void deleteLast()
{
    struct node *temp, *prevnode;
    if (start==NULL)
    printf("\nList is Empty\n");

    else
    {
        temp=start;
        while(temp->link!=0)
        {
            prevnode=temp;
            temp=temp->link;
        }

        free(temp);
        prevnode->link = 0;
    }
}
```

```
void deletePosition()
{
   struct node *temp, *position;
   int i=1, pos;

   if(start==NULL)
      printf("\nList is Empty\n");

   else
   {
      printf("Enter Position: ");
      scanf("%d", &pos);
      position=malloc(sizeof(struct node));
      temp=start;

      while(i<pos-1)
      {
         temp=temp->link;
         i++;
      }
      position = temp->link;
      temp->link = position->link;
      free(position);
   }
}

void display()
{
   struct node* temp;

   if (start == NULL)
      printf("\nList is empty\n");

   else
      {
      temp = start;
      while (temp != NULL)
         {
         printf("Element = %d\n", temp->info);
         temp = temp->link;
         }
      }
}
```

```
int main()
{
	printf("Singly Linked List Deletion and Display Operations");
	printf("\n1. Insert At First Position");
	printf("\n2. Insert At Last Position");
	printf("\n3. Insert At Any Position");
	printf("\n4. Delete At First Position");
	printf("\n5. Delete At Last Position");
	printf("\n6. Delete At Any Position");
	printf("\n7. Display Elements");
	printf("\n8. Exit\n");

	while(1){
	   int choice;
	   printf("\nEnter your choice: ");
	   scanf("%d", &choice);

	switch (choice)
	{
	case 1: insertFront();
		break;

	case 2: insertEnd();
		break;

	case 3: insertPosition();
		break;

	case 4: deleteFirst();
		display();
		break;

	case 5: deleteLast();
		display();
		break;

	case 6: deletePosition();
		display();
		break;

	case 7: display();
		break;

	case 8: exit(1);
		break;
```

```
        default: printf("Wrong choice!!!!!!\n");
        }
    }
    return 0;
}
```

2.6.3 Output:

//Inserting Elements in Singly Linked List

```
Singly Linked List Deletion and Display Operations
1. Insert At First Position
2. Insert At Last Position
3. Insert At Any Position
4. Delete At First Position
5. Delete At Last Position
6. Delete At Any Position
7. Display Elements
8. Exit

Enter your choice: 1

Enter number to be inserted : 10

Enter your choice: 3

Enter position and data :2
20

Enter your choice: 3

Enter position and data :3
30

Enter your choice: 3

Enter position and data :4
40

Enter your choice: 3

Enter position and data :5
50
```

```
Enter your choice: 3

Enter position and data :6
60

Enter your choice: 3

Enter position and data :7
70

Enter your choice: 3

Enter position and data :8
80
```

//Display Elements

```
Enter your choice: 7
Element = 10
Element = 20
Element = 30
Element = 40
Element = 50
Element = 60
Element = 70
Element = 80
```

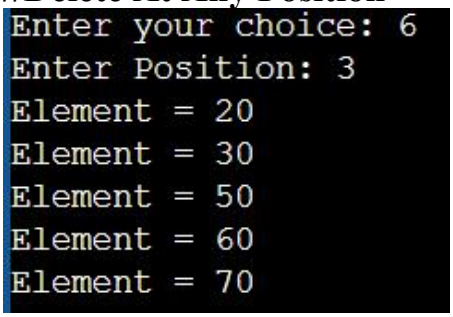
//Delete At First Position

```
Enter your choice: 4
Element = 20
Element = 30
Element = 40
Element = 50
Element = 60
Element = 70
Element = 80
```

//Delete At Last Position

```
Enter your choice: 5
Element = 20
Element = 30
Element = 40
Element = 50
Element = 60
Element = 70
```

//Delete At Any Position



2.7 Experiment: 7

2.7.1 Question:

WAP to Implement Single Link List with following operations:

a) Sort the linked list.
b) Reverse the linked list.
c) Concatenation of two linked lists.

2.7.2 Code:

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

struct node
{
	int info;
	struct node *link;
};

struct node* start = NULL;
struct node *create(struct node *start);
struct node *insert_s(struct node *start,int data);
struct node *insert(struct node *start,int data);

void display(struct node *start );
void merge(struct node *p1,struct node *p2);

void merge(struct node *p1,struct node *p2)
{
	struct node *start3;
	start3=NULL;

	while(p1!=NULL && p2!=NULL)
	{
		if(p1->info < p2->info)
		{
			start3=insert(start3,p1->info);
			p1=p1->link;
		}
		else if(p2->info < p1->info)
		{
			start3=insert(start3,p2->info);
			p2=p2->link;
		}
		else if(p1->info==p2->info)
		{
			start3=insert(start3,p1->info);
```

```
                p1=p1->link;
                p2=p2->link;
            }
        }

        while(p1!=NULL)
        {
            start3=insert(start3,p1->info);
            p1=p1->link;
        }

        while(p2!=NULL)
        {
            start3=insert(start3,p2->info);
            p2=p2->link;
        }
        printf("Merged list is : ");
        display(start3);
}

struct node *create(struct node *start )
{
        int i,n,data;
        printf("Enter the number of nodes : ");
        scanf("%d",&n);
        start=NULL;
        for(i=1;i<=n;i++)
        {
            printf("Enter the element to be inserted : ");
            scanf("%d",&data);
            start=insert_s(start, data);
        }
        return start;
}

struct node *insert_s(struct node *start,int data)
{
        struct node *p,*tmp;
        tmp=(struct node *)malloc(sizeof(struct node));
        tmp->info=data;

        if(start==NULL || data<start->info)
        {
            tmp->link=start;
            start=tmp;
            return start;
```

```
        }
        else
        {
                p=start;
                while(p->link!=NULL && p->link->info < data)
                        p=p->link;
                tmp->link=p->link;
                p->link=tmp;
        }
        return start;
}

struct node *insert(struct node *start,int data)
{
        struct node *p,*tmp;
        tmp=(struct node *)malloc(sizeof(struct node));
        tmp->info=data;

        if(start==NULL)
        {
                tmp->link=start;
                start=tmp;
                return start;
        }
        else
        {
                p=start;
                while(p->link!=NULL)
                        p=p->link;
                tmp->link=p->link;
                p->link=tmp;
        }
        return start;
}



void display(struct node *start)
{
        struct node *p;
        if(start==NULL)
        {
                printf("List is empty\n");
                return;
        }
        p=start;
```

```
        while(p!=NULL)
        {
                printf("%d ",p->info);
                p=p->link;
        }
        printf("\n");
}

void sort()
{
   struct node* current = start;
   struct node* index = NULL;
   int temp;

   if (start == NULL) {
      return;
   }

   else {
         while (current != NULL) {
         index = current->link;

         while (index != NULL) {
               if (current->info > index->info) {
                 temp = current->info;
                 current->info = index->info;
                 index->info = temp;
              }
              index = index->link;
         }
         current = current->link;
      }
   }
}

void reverseLL()
{
   struct node *t1, *t2, *temp;
   t1 = t2 = NULL;

   if (start == NULL)
      printf("List is empty\n");

   else {

      while (start != NULL) {
```

```
            t2 = start->link;
            start->link = t1;
            t1 = start;
            start = t2;
        }
        start = t1;

        temp = start;

        printf("Reversed linked list is : ");

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

void insertAtFront()
{
    int data;
    struct node* temp;
    temp = malloc(sizeof(struct node));
    printf("\nEnter number to be inserted : ");
    scanf("%d", &data);
    temp->info = data;
    temp->link = start;
    start = temp;
}

void insertAtEnd()
{
    int data;
    struct node *temp, *head;
    temp = malloc(sizeof(struct node));

    printf("\nEnter number to be inserted : ");
    scanf("%d", &data);

    temp->link = 0;
    temp->info = data;
    head = start;
    while (head->link != NULL) {
        head = head->link;
    }
```

```
    head->link = temp;
}

void insertAtPosition()
{
    struct node *temp, *newnode;
    int pos, data, i = 1;
    newnode = malloc(sizeof(struct node));

    printf("\nEnter position and data :");
    scanf("%d %d", &pos, &data);

    temp = start;
    newnode->info = data;
    newnode->link = 0;
    while (i < pos - 1) {
        temp = temp->link;
        i++;
    }
    newnode->link = temp->link;
    temp->link = newnode;
}

void traverse()
{
    struct node* temp;

    if (start == NULL)
        printf("\nList is empty\n");

    else {
        temp = start;
        while (temp != NULL) {
            printf("Data = %d\n", temp->info);
            temp = temp->link;
        }
    }
}

int main()
{
    int choice;
    struct node *start1=NULL,*start2=NULL;

    printf("Singly Link List Sort, Reverse & Concatenate Operations");
    printf("\n1. Display List\n");
```

```
printf("2. Insert At First Position\n");
printf("3. Insert At Last Position\n");
printf("4. Insert At Any Position\n");
printf("5. Sort The List\n");
printf("6. Reverse the list\n");
printf("7. Concatenate 2 Linked Lists\n");
printf("8. To exit\n");

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

   switch (choice) {
   case 1: traverse();
           break;

   case 2: insertAtFront();
           break;

   case 3: insertAtEnd();
           break;

   case 4: insertAtPosition();
           break;

   case 5: sort();
           traverse();
           break;

   case 6: reverseLL();
           break;

   case 7: start1=create(start1);
           start2=create(start2);
           printf("List1 : ");
           display(start1);
           printf("List2 : ");
           display(start2);
           merge(start1, start2);
           break;

   case 8: exit(1);
           break;

   default: printf("Incorrect Choice\n");
   }
```

```
    }
    return 0;
}
```

2.7.3 Output:

//Insert Elements in Singly Linked List

```
Singly Link List Sort, Reverse & Concatenate Operations
1. Display List
2. Insert At First Position
3. Insert At Last Position
4. Insert At Any Position
5. Sort The List
6. Reverse the list
7. Concatenate 2 Linked Lists
8. To exit

Enter Choice:
2

Enter number to be inserted : 11

Enter Choice:
3

Enter number to be inserted : 67

Enter Choice:
4

Enter position and data :2
36

Enter Choice:
4

Enter position and data :3
35

Enter Choice:
4

Enter position and data :4
15
Enter Choice:
4

Enter position and data :5
22
```

//Display Elements

```
Enter Choice:
1
Data = 11
Data = 36
Data = 35
Data = 15
Data = 22
Data = 67
```

//Sort the List

```
Enter Choice:
5
Data = 11
Data = 15
Data = 22
Data = 35
Data = 36
Data = 67
```

//Concatenate 2 Linked List

```
Enter Choice:
6
Reversed linked list is : 67 36 35 22 15 11
Enter Choice:
7
Enter the number of nodes : 4
Enter the element to be inserted : 10
Enter the element to be inserted : 50
Enter the element to be inserted : 23
Enter the element to be inserted : 15
Enter the number of nodes : 5
Enter the element to be inserted : 1
Enter the element to be inserted : 3
Enter the element to be inserted : 5
Enter the element to be inserted : 7
Enter the element to be inserted : 9
List1 : 10 15 23 50
List2 : 1 3 5 7 9
Merged list is : 1 3 5 7 9 10 15 23 50
```

2.8 Experiment: 8

2.8.1 Question:
WAP to implement Stack & Queues using Linked Representation.

2.8.2 Code:
```
#include <stdio.h>
#include <stdlib.h>

int main()
{
int choice, value;
        printf("\nImplementation of Stack and Queues using Linked List\n");
        printf("\nStack Operations\n");
        printf("1. Push\n2. Pop\n3. Display\n");
        printf("\nQueue Operations\n");
        printf("4.Enqueue\n5.Dequeue\n6.Display\n7.Exit\n");

        while (1)
        {
                printf("\nEnter your choice : ");
                scanf("%d", &choice);

                switch (choice)
                {
                        case 1: printf("\nEnter the value to insert: ");
                                scanf("%d", &value);
                                push(value);
                                break;

                        case 2: printf("Popped element is :%d\n", pop());
                                break;

                        case 3: displayStack();
                                break;

                        case 4: printf("\nEnter the value to insert: ");
                                scanf("%d", & value);
                                enqueue(value);
                                break;

                        case 5: printf("Popped element is :%d\n", dequeue());
                                break;

                        case 6: displayQueue();
                                break;
```

```
                    case 7: exit(0);
                            break;

                default: printf("\nWrong Choice\n");
            }
        }
}

//Stack Implementation
struct Node
{
        int data;
        struct Node *next;
};

struct Node* top = NULL;

void push(int value)
{
        struct Node *newNode;
        newNode = (struct Node *)malloc(sizeof(struct Node));
        newNode->data = value;

        if (top == NULL)
        {
                newNode->next = NULL;
        }

        else
        {
                newNode->next = top;
        }

        top = newNode;
        printf("Node is Inserted\n\n");
}

int pop()
{
        if (top == NULL)
        {
                printf("\nStack Underflow\n");
        }
```

```
        else
        {
                struct Node *temp = top;
                int temp_data = top->data;
                top = top->next;
                free(temp);
                return temp_data;
        }
}

void displayStack()
{
        if (top == NULL)
        {
                printf("\nStack Underflow\n");
        }

        else
        {
                printf("The stack is \n");
                struct Node *temp = top;

                while (temp->next != NULL)
                {
                        printf("%d--->", temp->data);
                        temp = temp->next;
                }

        printf("%d--->NULL\n\n", temp->data);
        }
}

//Queue Implementation
struct node
{
        int data;
        struct node * next;
};

struct node * front = NULL;
struct node * rear = NULL;

void enqueue(int value)
{
        struct node * ptr;
        ptr = (struct node *) malloc(sizeof(struct node));
```

```
        ptr -> data = value;
        ptr -> next = NULL;

        if ((front == NULL) && (rear == NULL))
        {
                front = rear = ptr;
        }

        else
        {
                rear -> next = ptr;
                rear = ptr;
        }

        printf("Node is Inserted\n\n");
}

int dequeue()
{
        if (front == NULL)
        {
                printf("\nUnderflow\n");
        }

        else
        {
                struct node * temp = front;
                int temp_data = front -> data;
                front = front -> next;
                free(temp);
                return temp_data;
        }
}

void displayQueue()
{
        struct node * temp;
        if ((front == NULL) && (rear == NULL))
        {
                printf("\nQueue is Empty\n");
        }

        else
        {
                printf("The queue is \n");
                temp = front;
```

```
            while (temp)
            {
                printf("%d--->", temp -> data);
                temp = temp -> next;
            }

        printf("NULL\n\n");
        }
}
```

Output:

//Stack Operations

```
Implementation of Stack and Queues using Linked List

Stack Operations
1. Push
2. Pop
3. Display

Queue Operations
4.Enqueue
5.Dequeue
6.Display
7.Exit

Enter your choice : 1

Enter the value to insert: 10
Node is Inserted


Enter your choice : 1

Enter the value to insert: 20
Node is Inserted


Enter your choice : 1

Enter the value to insert: 30
Node is Inserted


Enter your choice : 1

Enter the value to insert: 40
Node is Inserted
```

```
Enter your choice : 3
The stack is
40--->30--->20--->10--->NULL


Enter your choice : 2
Popped element is :40

Enter your choice : 2
Popped element is :30

Enter your choice : 2
Popped element is :20

Enter your choice : 2
Popped element is :10

Enter your choice : 3

Stack Underflow
```

//Queue Operations

```
Enter your choice : 4

Enter the value to insert: 10
Node is Inserted


Enter your choice : 4

Enter the value to insert: 20
Node is Inserted


Enter your choice : 4

Enter the value to insert: 30
Node is Inserted


Enter your choice : 4

Enter the value to insert: 40
Node is Inserted


Enter your choice : 4

Enter the value to insert: 50
Node is Inserted
```

```
Enter your choice : 6
The queue is
10--->20--->30--->40--->50--->NULL


Enter your choice : 5
Popped element is :10

Enter your choice : 5
Popped element is :20

Enter your choice : 5
Popped element is :30

Enter your choice : 5
Popped element is :40

Enter your choice : 5
Popped element is :50

Enter your choice : 6
The queue is
NULL
```

2.9 Experiment: 9

2.9.1 Question:

WAP to Implement doubly link list with primitive operations:

a) Create a doubly linked list.
b) Insert a new node to the left of the node.
c) Delete the node based on a specific value.
d) Display the contents of the list.

2.9.2 Code:

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

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

struct node* start = NULL;

void insertFront()
{
   int data;

   struct node* temp;

   temp=(struct node*)malloc(sizeof(struct node));

   printf("Enter Number to be inserted: ");
   scanf("%d",&data);

   temp->info = data;
   temp->prev = NULL;

   temp->next = start;
   start = temp;
}

void insertEnd()
{
   int data;
   struct node *temp, *trav;
   temp=(struct node*)malloc(sizeof(struct node));
   temp->prev = NULL;
   temp->next = NULL;
   printf("Enter the Number to be inserted: ");
```

```
    scanf("%d", &data);
    temp->info=data;
    temp->next=NULL;
    trav=start;

    if (start == NULL)
    {
        start = temp;
    }

    else
    {
       while (trav->next != NULL)
       trav = trav->next;
       temp->prev = trav;
       trav->next = temp;
    }
}

void insertPosition()
{
    int data, pos, i=1;
    struct node *temp, *newnode;

    newnode = malloc(sizeof(struct node));
    newnode->prev = NULL;
    newnode->next = NULL;

    printf("Enter position: ");
    scanf("%d", &pos);

     if (start == NULL) {
       start = newnode;
       newnode->prev = NULL;
       newnode->next = NULL;
    }

    else if (pos == 1)
    {
       insertFront();
    }

    else
    {
       printf("\nEnter number to be inserted: ");
       scanf("%d", &data);
```

```
        newnode->info = data;
        temp = start;

        while (i < pos - 1)
        {
            temp = temp->next;
            i++;
        }

        newnode->next = temp->next;
        newnode->prev = temp;
        temp->next = newnode;
        temp->next->prev = newnode;
    }
}

void deleteFirst()
{
    struct node* temp;

    if (start == NULL)
        printf("\nList is empty\n");

    else
    {
        temp = start;
        start = start->next;
        if (start != NULL)
        start->prev = NULL;

        free(temp);
    }
}

void deleteEnd()
{
    struct node* temp;
    if (start == NULL)
        printf("\nList is empty\n");
    temp = start;
    while (temp->next != NULL)
        temp = temp->next;
    if (start->next == NULL)
        start = NULL;
    else {
        temp->prev->next = NULL;
```

```
        free(temp);
    }
}

void deletePosition()
{
    int pos, i = 1;
    struct node *temp, *position;
    temp = start;

    if (start == NULL)
        printf("\nList is empty\n");

    else
    {
        printf("\nEnter position : ");
        scanf("%d", &pos);

        if (pos == 1)
        {
            deleteFirst();

            if (start != NULL)
            {
                start->prev = NULL;
            }

            free(position);
            return;
        }

        while (i < pos - 1)
        {
            temp = temp->next;
            i++;
        }

        position = temp->next;
        if (position->next != NULL)
            position->next->prev = temp;

        temp->next = position->next;

        free(position);
    }
}
```

```
void traverse()
{
   if (start == NULL)
   {
      printf("\nList is empty\n");
      return;
   }

   struct node* temp;
   temp = start;

   while (temp != NULL)
   {
      printf("Data = %d\n", temp->info);
      temp = temp->next;
   }
}

int main()
{      printf("Doubly Linked List Insert & Delete Operations");
       printf("\n1. Display List\n");
       printf("2. Insert At Front\n");
       printf("3. Insert At End\n");
       printf("4. Insert At Position\n");
       printf("5. Delete First Element\n");
       printf("6. Delete Last Element\n");
       printf("7. Delete From Any Position\n");
       printf("8. Exit\n");

       while (1)
       {
          int choice;
          printf("\nEnter Choice: \n");
          scanf("%d", &choice);

       switch (choice)
       {
       case 1: traverse();
                 break;

       case 2: insertFront();
                 break;

       case 3: insertEnd();
                 break;
```

```
        case 4: insertPosition();
                break;

        case 5: deleteFirst();
                traverse();
                break;

        case 6: deleteEnd();
                traverse();
                break;

        case 7: deletePosition();
                traverse();
                break;

        case 8: exit(1);
                break;

        default: printf("Incorrect Choice. Try Again \n");
        }
    }
    return 0;
}
```

2.9.3 Output:

//Inserting Elements in Doubly Linked List

```
Doubly Linked List Insert & Delete Operations
1. Display List
2. Insert At Front
3. Insert At End
4. Insert At Position
5. Delete First Element
6. Delete Last Element
7. Delete From Any Position
8. Exit

Enter Choice:
2
Enter Number to be inserted: 10

Enter Choice:
3
Enter the Number to be inserted: 50

Enter Choice:
4
Enter position: 2

Enter number to be inserted: 20

Enter Choice:
4
Enter position: 3

Enter number to be inserted: 30

Enter Choice:
4
Enter position: 4

Enter number to be inserted: 40
```

//Display Elements in Doubly Linked List

```
Enter Choice:
1
Data = 10
Data = 20
Data = 30
Data = 40
Data = 50
```

//Delete First Element

```
Enter Choice:
5
Data = 20
Data = 30
Data = 40
Data = 50
```

//Delete Last Element

```
Enter Choice:
6
Data = 20
Data = 30
Data = 40
Data = 978262720
```

//Delete Element from Any Position

```
Enter Choice:
7

Enter position : 2
Data = 20
Data = 40
Data = 978262720
```

2.10 Experiment: 10

2.10.1 Question:

Write a program:

a) To construct a binary Search tree.
b) To traverse the tree using all the methods i.e., in-order, preorder and post order.
c) To display the elements in the tree.

2.10.2 Code:

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

struct node
{
   int data;
   struct node *left;
   struct node *right;
};

struct node *tree;

void create_tree(struct node *);
struct node *insertElement(struct node *, int);
void preorderTraversal(struct node *);
void inorderTraversal(struct node *);
void postorderTraversal(struct node *);

int main()
{
        int option, val;
        struct node *ptr;
        create_tree(tree);

        printf("Binary Search Tree Operations:\n");
        printf("1. Insert Element");
        printf("\n2. Preorder Traversal");
        printf("\n3. Inorder Traversal");
        printf("\n4. Postorder Traversal");
        printf("\n5. Exit");

  do
    {
                printf("\n\n Enter your option : ");
                scanf("%d", &option);
```

```
            switch(option)
            {
                case 1:
                    printf("\n Enter the value of the new node : ");
                    scanf("%d", &val);
                    tree = insertElement(tree, val);
                    break;
                case 2:
                    printf("\n The elements of the tree are : \n");
                    preorderTraversal(tree);
                    break;
                case 3:
                    printf("\n The elements of the tree are : \n");
                    inorderTraversal(tree);
                    break;
                case 4:
                    printf("\n The elements of the tree are : \n");
                    postorderTraversal(tree);
                    break;
            }
        }
        while(option!=14);
        getch();
        return 0;
}

void create_tree(struct node *tree)
{
   tree = NULL;
}

struct node *insertElement(struct node *tree, int val)
{
   struct node *ptr, *nodeptr, *parentptr;
   ptr = (struct node*)malloc(sizeof(struct node));
   ptr->data = val;
   ptr->left = NULL;
   ptr->right = NULL;

   if(tree==NULL)
   {
            tree=ptr;
            tree->left=NULL;
            tree->right=NULL;
   }
```

```
   else
   {
            parentptr=NULL;
            nodeptr=tree;
            while(nodeptr!=NULL)
   {
        parentptr=nodeptr;

        if(val<nodeptr->data)
           nodeptr=nodeptr->left;

        else
              nodeptr = nodeptr->right;
   }
            if(val<parentptr->data)
                  parentptr->left = ptr;

            else
                  parentptr->right = ptr;
   }
return tree;
}

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

}

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

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

}
```

2.10.3 Output:

//Insertion of Number in tree

```
Binary Search Tree Operations:
1. Insert Element
2. Preorder Traversal
3. Inorder Traversal
4. Postorder Traversal
5. Exit

 Enter your option : 1

 Enter the value of the new node : 10


 Enter your option : 1

 Enter the value of the new node : 20


 Enter your option : 1

 Enter the value of the new node : 25


 Enter your option : 1

 Enter the value of the new node : 35


 Enter your option : 1

 Enter the value of the new node : 2


 Enter your option : 1

 Enter the value of the new node : 3
```

```
Enter your option : 1

Enter the value of the new node : 85


Enter your option : 1

Enter the value of the new node : 75


Enter your option : 1

Enter the value of the new node : 54


Enter your option : 1

Enter the value of the new node : 43
```

//In - Order traversal

```
Enter your option : 3

The elements of the tree are :
2       3       10      20      25      35      43      54      75      85
```

//Pre - Order traversal

```
Enter your option : 2

The elements of the tree are :
10      2       3       20      25      35      85      75      54      43
```

//Post - Order traversal

```
Enter your option : 4

The elements of the tree are :
3       2       43      54      75      85      35      25      20      10
```