VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

DATA STRUCTURE LAB RECORD

Submitted by

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Under the Guidance of

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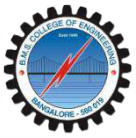
in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING



B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019

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B. M. S. College of Engineering,

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(Affiliated To Visvesvaraya Technological University, Belgaum)

Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the LAB RECORD carried out by **SHREEHARI (1BM19CS153)** who is the bonafide students 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 Visveswaraiah Technological University, Belgaum during the year 2020-2021. The lab report has been approved as it satisfies the academic requirements in respect of **DATA STRUCTURE LAB RECORD (19CS3PCDST)** work prescribed for the said degree.

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1._____ _____

2. _____ _____

INDEX

LAB 1 program

NAP to simulate the working of stack using an array

- a push
- pop
- display

Program should print appropriate message for stack overflow and underflow.

Page No.

Date / /

```
#include<stdio.h>
#define STACK_SIZE 5
int top=-1
int s[10];
int item
void push()
{
    if(top == STACK_SIZE-1)
    {
      printf(" stack overflow\n");
      return;
    }
    top+=1
    s[top]=item
}

int pop()
{
    if (top==-1)
    return -1

  return s[top--]
}

void display()
{
    int ;
    if (top==-1)
    {
      printf(" Stack is empty\n");
      return;
    }
}
```

Saathi

Date __/__/____

```
for(i = top ; i >= 0; i--)
{
    printf("%d\n", s[i]);
}
}

void main()
{
    int item_deted
    int choice;
    for(;;)
    {
      printf("\n1: Push\n2: Pop\n3: display
                \n4: exit\n");

      printf("Enter the choice\n");
      switch(choice)
      {
        case 1:
        printf("Enter the item to be inserted
                \n");

        scanf("%d", &item);
        push()
        break;
```

Saathi

Date / /

```
case 2:
    item_deleted = pop();
    if (item_deleted == -1)
        printf("Stack is empty\n");
    else
        printf("Deleted item is %d\n", item_deleted);
    }
    break;
case 3:
    display();
    break;
default:
case 4:
    exit(0)
}
}
```

Page No.

OUTPUT:

1: Push
2: Pop
3: display
4: exit

Enter your choice
1
Enter the item to be inserted
25

1: Push
2: pop
3: display
4: exit
Enter your choice
1
Enter the item to be insated
26

1: Push
2: pop
3: display
4: exit
Enter your choice
1
Enter the item to be inserted
27

1: Push
2: pop
3: display
4: exit

Enter your choice
3

Elements of Stack are
27
26
25

1: Push
2: Pop
3: display
4: exit
Enter your choice
2
Deleted item is 27

1: Push
2: Pop
3: display
4: exit
Enter your choice
2
Deleted item is 26

1: Push
2: Pop
3: display
4: exit
Enter your choice
2
Deleted item is 25

Date __/__/____

Saathi

1: push
2: Pop
3: display
4: exit
Enter your choice
2
STACK is empty

1: PUSH
2: POP
3: display
4: exit
Enter your choice
3
Elements of stack are
STACK IS EMPTY NO ITEM CAN BE PRINTED

1: Push
2: Pop
3: display
4: exit

4.

Saathi

Date __/__/____

Week2: Write a program to convert infix to postfix using stacks.

```
#include<stdio.h>
#include<string.h>
int F(char symbol)
{
    switch(symbol)
    {
        case '+':
        case '-':
            return 2;

        case '*':
        case '/':
            return 4;

        case '^':
        case '$':
            return 5;

        case '(':
            return 0;

        case '#'
            return -1;

        default:
            return 8
    }

}
```

Page No.

Date __/__/____

Saathi

```
int G(char symbol)
{
    switch(symbol)
    {

      case '+':
      case '-':
        return 1;

      case '*'
      case '/'
        return 3;

      case '^':
      case '$':
        return 6;

      case 'c':
        return 9;

      case '('
        return 0

      default
        return 7

    }

}
```

Saathi

Date / /

```
void infix_postfix(char infix[], char postfix[])
{
    int top, i, j;
    char s[30], Symbol;
    top = -1;
    s[++top] = '#';
    j = 0;
    for(i=0; i< strlen(infix); i++)
    {
        Symbol = infix[i];
        while(F(s[top]) > G(Symbol))
        {
            postfix[j] = s[top--];
            j++;
        }
        if(F(s[top]) != G(Symbol))
            s[++top] = Symbol;
        else
            top--
    }
    while(s[top] != '#')
    {
        postfix[j++] = s[top--];
    }
}
void main()
{
    char infix[20];
    char postfix[20];
```

Date __/__/____

Saathi

(1)
```
printf("Enter the valid expression\n");
scanf("%s", infix);
infix_postfix(infix, postfix);
printf("postfix is \n");
printf("%s\n", postfix);
}
```

OUTPUT

Enter the valid Expression

(A + (B-C) * D)

Post fix Expression is

ABC - D* + .

WEEK 5

Date

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I mplementing circular Queue

```
#include <stdio.h>
# define MAX 5
int Queue[MAX]
int front = -1, rear = -1
void insert (Void) ;
int delete (Void);
void display(Void);
int main()
{
  int option, val
  clrscr()
  do
  {
      printf ("\n1: Insert\n");
      printf ("\n2: Delete\n");
      printf ("\n3: Display\n");
      printf ("Enter your option\n");
      scanf ("%d", &option);
      switch (option)
      {
          case 1:
              insert()
              break;

          case 2:
              Vale = delet();
              if (Val != -1)
              printf ("Deleted Number is %d\n",
                                  Val);
              break;

          case3: display()
              break
  } }
```

Page No.

Saathi

Date ___/___/___

```
{ while (option != 5)
  return 0

Void insert()
{
    int num;
    printf("Enter the number to be added\n");
    scanf("%d", &num);
    if (front == 0 && rear == MAX-1)
        printf("overflow\n");

    else if (front == -1 && rear == -1)
    {
        front = rear = 0
        queue[rear] = num
    }

    else if (rear == MAX-1 && front != 0)
    {
        rear = 0
        queue[rear] = num;
    }
    else
    {
        rear ++
        queue[rear] = num;
    }
}
```

```
int delete()
{
  int Val
  if (front == -1 && rear == -1)
  {
     printf ("\n Underflow");
     return -1
  }
  Val = queue[front]
  if (front == rear)
  {
     front = rear = -1
  }
  else
  {
     if (front = Max-1)
        front = 0
     else
        front++
  }
return Val
}
Void display()
{
  int i
  printf ("\n");
  if (front == -1 && rear == -1)
     print ("\n Queue is empty");
  else
  {
     if (front < rear)
```

Saathi

Date ___/___/_____

```
{
    for( int i = front; i<max; i++)
        printf("%d", queue[i]);
    for(i=0;
}
else
{
    for(int i = front; i<Max; i++)
        printf("%d", queue[i]);
    for(int i=0; i<= rear; i++)
        printf("%d\n", queue[i]);
}
}
}
```

Date ___/___/_____

Saathi

OUTPUT

1: INSERT
2: DELETE
3: DISPLAY
4: EXIT
Enter your option
1
Enter the number to be inserted
10

1: INSERT
2: DELETE
3: DISPLAY
4: EXIT
Enter your option
3

10

Saathi

Date __/__/__

Implementing Linear Queue

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>
#define max 5
int q[max]
int front=-1, rear=-1
void insert();
int delete();
void display();
int main()
{
    int option, val
    printf("*** Menu ***\n");
    printf("1: Insert\n");
    printf("2: Delete\n");
    printf("3: Display\n");
    printf("4: exit\n");
    printf("Enter the option\n");
    scanf("%d", &option);
    switch(option)
    {
        case 1:
            insert()
            break;

        case 2:
            val = delete();
            if (val != -1)
                printf("Item deleted
                is: %d\n", val);
```

```
        break;

    case 3:
            display();
            break;

    case 4:
            exit(0)
    }

} while (option!=5);
  return 0

}

void insert()
{
    int num;
    printf("Enter the item to be inserted \n");
    scanf("%d", &num);
    if (rear == max-1)
    {
        printf("overflow\n");
    }
    if (front==-1 && rear==-1)
    {
        front=0;
        rear=0;
        q[rear]=num;
    }
    else
    {
        rear++;
        q[rear]=num;
```

```
int delete()
{
    int val
    if( front==-1 || front>rear)
    {
        printf("UNDERFLOW\n");
        return -1;
    }
    else
    {
        val = q[front]
        front++;
        if( front>rear)
            front=-1;
            rear=-1;
        }
        return val
    }
}

void display()
{
    if( front==-1 || front>rear)
    {
        printf("Queue is Empty\n");
    }
    else
    {
        for(int i = front; i<=rear; i++
        {
            printf("%d\n", q[i]);
        }
    }
}
```

OUTPUT

1: Insert
2: Delete
3: Display
Enter your option
1
Enter the number to inserted
2

1: insert
2: Delete
3: Display
4: exit
Enter your option
1
Enter the number to be inserted
6
1: insert
2: Delete
3: display
4: exit
Enter your option
3

2
6

Date __/__/____

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linkdist programm

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

Struct node
{
  intdata;
 Struct node *next;
};
 typedef struct node *NODE;

 Void swap (NODE a, NODE b);
 NODE getNode()
{
   NODE x;
   x = malloc (sizeof (structnode));
    if (x = NULL)
   {
      exit(0);
   }
    else
   } return x;
     }
}
   NODE insert_front (int item, NODE
                                 start)
{     NODE temp;
      temp = getNode();
      temp -> data = item;
      temp -> next = start;
```

Page No.

Date __/__/__

Saathi

```
start = temp;
return start;
}
NODE insert_end (int item, NODE start)
{
NODE insert_end (int item, NODE start)
{
NODE temp, cur;
temp = getNode();
temp -> data = item;
temp -> next = NULL;
cur = start;
while (cur -> next != NULL)
{
cur = cur -> next;
}
cur -> next = temp;
return start;
}
NODE insert_pos (int pos, int item,
                 NODE start)
{ NODE temp, prev, cur;
temp = getNode();
temp -> data = item;
temp -> next = NULL;
if (pos == 1 && start == NULL)
{
return temp;
}
if (start == NULL)
{
printf ("Invalid position\n");
return start;
}
if (pos == 1)
```

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Date __/__/____

```
}
    temp -> next = start;
    return temp;
}
    int count = 1;
    cur = start;
    prev = NULL;
    while (cur != NULL && count != pos)
    {
        prev = cur;
        cur = cur -> next;
        count++;
    }
    if (count == pos)
    {
        prev -> next = temp;
        temp -> next = cur;
        return start;
    }
    Printf ("Invalid position \n");
    return start;
}

    NODE temp;
    if (start == NULL)
    {
        printf ("List Is empty And Cannot Be
                 Displayed \n");
        exit (0);
    }
        temp = start;
        Printf("items are \n");
        printf (" \n");
    for (temp = start ; temp != NULL;
```

Saathi

Date __/__/____

```
temp = temp -> next)
{
  Printf ("%d\n", temp -> data);
}
Printf ("\n");
return Start;
}
Void bubbleSort (NODE Start)
{
 int swapped, i;
 NODE cur;
 NODE Prev = NULL)
{
  Printf ("Empty LinKed List\n");
  Return;
}
  do
{
  Swapped = 0;
  cur = Start;
 while (cur -> next != Prev)
{
  if (cur -> data > cur -> next -> data)
  }
  Swap (cur, cur -> next);
  Swapped = 1;
  }
  Cur = cur -> next;
}
  Prev = cur;
}
 while (swapped);
}
 Void swap (NODE a, NODE b)
```

Saathi
Date __/__/____

```
{
    int temp = a -> data;
    a -> data = b -> data;
    b -> data = temp;
}
Void reverseList (NODE Start)
{
    NODE Prev, Cur;
    if (Start != NULL)
    {
     Prev = Start;
     Start = Start -> next;
     cur = Start;
     Prev ==> next = NULL; // Make first Node as
                              last node
    while (Start != NULL)
    {
     Start = Start -> next;
     Cur -> next = Prev;
     Prev = Cur;
     Cur = Start;
    }
    Start = Prev; // make last node as head
    Print ("SUCCESSFULLY REVERSED) LISTIN");
}
    NODE temp;
    temp = Start;
    printf ("Reversed List is \n");
    while (temp != NULL)
    {
     Printf ("%d\n", temp -> data);
     temp = temp -> next;
    }
}
```

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Date __/__/____

```
int main()
{
 int option, item, pos;
 NODE start = NULL;
 do
 {
 Printf("1: Insert Front\n");
 Printf("2: Insert End\n");
 Printf("3: Insert At particular position\n");
 Printf("4: Delete First\n");
 printf("5: Delete End\n");
 Printf("6: Delete At particular position\n");
 Printf("7: Display\n");
 Printf("8: Sort\n");
 Printf("9: Reverse\n");
 Printf("10: exit\n");
 Printf("Enter your choice\n");
 Scanf (~~option~~) ("%d", &option);
 Switch (option)
 {
  case 1:
   printf("Enter the item to be inserted\n");
   Scanf("%d", &item);
   start = insert_front(item, start);
   break;
  case 2:
        printf("Enter the item to be
                inserted\n");
       Scanf("%d", &item);
       Start = insert_end(item, start);
        break;
    case 3:
    Printf("Enter the item to be inserted
```

Saathi

Date / /

```
scanf ("%d", &pos);
start = insert_pos (pos, item, start);
break;

case 4;
    start = delete_front (start);
    break;

case 5:
    start_delete_end (start);
    break;

case 6:
    printf ("Enter the position where element
             has to be inserted \n");
    scanf ("%d", &pos);
    start = delete_pos (pos, start);
    break;

case 7:
    start = display (start);
    break;

case 8:
    bubblesoart (start);
printf (" Items In Sorted order are\n
start = display (start);
break;

case 9;
    reverselist (start);
    break;
}
} while (option != 10);
}
```

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Date ___/___/_____

```
Node reverse(Node first)
{
Node cur, prev, temp;
if(first==NULL)
{
printf("List is Empty\n");
return first;
}
cur = NULL;
while(first!=NULL)
{
temp = first;
first = first->next);
temp-> next = cur;
cur = temp;
}
return cur;
}
void sort(Node first)
{
int t;
Node temp;
if(first==NULL)
{
printf("List IS Empty\n");
return;
}
for(Node i=first; i!=NULL; i=i->next)
{
for(Node j=i->next; j!=NULL
                j=j->next)
{
if((i->item) > (j->item))
```

Saathi

Date / /

```
    t = i -> item;
    i -> item = j -> item
    j -> item = t;
  }
}

Node concat (Node first, Node second)
{
  Node cur;
  if (first == NULL)
  {
    first = second;
    return first;
  }
  if (second == NULL)
  {
    return first;
  }
  cur = first;
  while (cur -> next != NULL)
  {
    cur = cur -> next;
  }
  cur -> next = second;
  printf("Final Concatinated List is\n");
  return first;
}
```

Date ___/___/___

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

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

Node getnode()
{
    Node x;
    x = (Node) malloc(sizeof(struct node));
    return x;
}

Node insert_front(Node first, int data)
{
    Node new_node;
    new_node = getNode();
    new_node -> item = data;
    new_node -> next = NULL;
    if (first == NULL)
    {
        return new_node;
    }
    new_node -> next = first;
    first = new_node;
    return first;
}
```

Date ___/___/___

Saathi

```
Node delete_end(Node first)
{
    Node prev, cur;
    if (first == NULL)
    {
        printf("underflow\n");
        return first;
    }
    cur = first;
    while (cur -> next != NULL)
    {
        prev = cur;
        cur = cur -> next;
    }
    prev -> next = NULL;
    free(cur);
    return first;
}
Void search(Node first, int data)
{
    int pos = 0;
    Node temp;
    int i;
    if (first == NULL)
    {
        printf("underflow\n");
        return;
    }
}
```

```
for (temp = first; i=0; temp != NULL;
                        temp = temp->next;
                                    i++)
{
    if (temp -> item == data)
    {
        pos = i + 1;
        printf ("Search successful \n");
        printf ("Element found at %d \n",
                                    pos);
        break;
    }
    else
    {
        pos = 0;
    }
}
if (pos == 0)
{
    printf ("Search unsuccessful \n");
}
}
```

Date ___/___/___

Saathi

```
void sort (Node first)
{
    int t;
    Node temp;
    if (first == NULL)
    {
        printf ("list empty\n");
        return;
    }
    for (Node i = first; i != NULL; i = i->next)
        for (Node j = i->next; j != NULL; j = j->next)
            if ((i->item) > (j->item))
            {
                t = i->item;
                i->item = j->item;
                j->item = t;
            }
    printf ("list in sorted order is \n");
}
```

Saathi

Date ___/___/_____

```
void display(Node first)
{
    int count=0;
    Node temp;
    if (first == NULL)
    {
        printf("underflow\n");
        return;
    }
    for (temp= first; temp != NULL; temp= temp->next)
    {
        count++;
        printf("%d\n", temp->item);
    }
    printf("Number of Nodes %d\n", count);
}

int main()
{
    Node first = NULL;
    int val, n;
    do
    {
        printf("1: Insert at front\n");
        printf("2: Delete Rear\n");
        printf("3: Sort\n");
```

Date __/__/__

Saathi

```
printf("4: Search\n");
printf("5: Display\n");
printf("6: exit\n");
printf("Enter your choice\n");
scanf("%d", &choice);
switch(choice)
{
  case 1:
      printf("Enter the value to be inserted\n");
      scanf("%d", &val);
      first = insert_front(first, val);
      break;

  case 2:
      first = delete_end(first);
      break;

  case 3:
      sort(first);
      break;

  case 4:
      printf("Enter the element to be searched\n");
      scanf("%d", &n);
      search(first, n);
      break;

  case 5:
      display(first);
      break;
}while(option != 6);
```

Page No.

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```
#include<stdio.h>
#include<math.h>
#include<stdio.h>
struct node
{
    int info
    struct node *rlink;
    struct node *llink;
};
typedef struct node * NODE
NODE getnode()
{
    NODE x;
    x = (NODE) malloc( sizeof( struct node));
    if (x==NULL)
    {
        printf ("memory full\n");
        exit(0);
    }
    return x;
}
void freenode(NODE x)
{
    free(x);
}
NODE insert_front(int item, NODE head)
{
```

```
NODE x;
NODE temp, cur;
temp = getnode();
temp -> info = item;
cur = head -> rlink;
head -> rlink = temp;
temp -> llink = head;
temp -> rlink = cur;
cur -> llink = temp;
return head
}
NODE insert_end(int item, NODE head)
{
    NODE temp, cur;
    temp = getnode();
    temp -> info = item;
    cur = head -> rlink;
    head -> rlink = temp;
    temp -> llink = head;
    temp -> rlink = cur;
    cur -> llink = temp;
    return head
}

NODE delete_front(NODE head)
{
    NODE cur, next;
    if (head -> rlink == head)
    {
        printf("Empty list\n");
        return head;
    }
```

```
cur = head->rlink;
next = cur->rlink;
head->rlink = next;
next->llink = head;
printf("The node deleted is %d\n", cur->info);

free(cur);
return head
}

NODE delete_rear(NODE head)
{
    NODE cur, prev;
    if(head->rlink == head)
    {
        printf("Empty\n");
        return head;
    }
    cur = head->llink;
    prev = cur->llink;
    head->llink = prev;
    prev->rlink = head;
    printf("Node deleted is %d\n", cur->info);
    free(cur);
    return head;
}
void display(NODE head)
{
    NODE temp;
    if(head->rlink == head)
    {
        printf("Empty\n");
        return;
    }
```

```
}
printf ("Contents \n");
temp = head -> rlink;
while (temp != head)
{
    printf ("%d \n", temp -> info);
    temp = temp -> rlink;
}
printf ("\n");
}

NODE insert_leftpos(int item, NODE head)
{
    NODE temp, cur, prev;
    if (head -> rlink == head)
    {
        printf ("Empty \n");
        return head;
    }
    cur = head -> rlink;
    while (cur != head)
    {
        if (item == cur -> info)
        {
            break;
        }
        cur = cur -> rlink;
    }
    if (cur == head)
    {
        printf ("Key not found \n");
        return head;
    }
```

prev = cur -> llink;
printf("Enter toward left of %d = ", item);
temp = getnode();
scanf("%d", &temp->info);
prev -> rlink = temp;
temp -> llink = prev;
cur -> llink = temp;
temp -> rlink = cur;
return head
}

NODE insert_right_pos(int item, NODE head

15 x 16 + 15 x 16^0

240 + 15.

{
NODE temp, cur, prev
if (head -> rlink == head)
{
printf("empty\n");
return head
}
cur = head -> rlink;
while (cur != head)
{
if (item == cur -> info)
break;
cur = cur -> rlink.
}
if (cur == head)
printf("key not found\n");
return head

}

```
prev = cur -> llink
printf("Enter toward right of %d = ", item)
temp = getnode();
Scanf("%d", & temp -> info);
temp -> rlink = cur -> rlink
temp -> llink = cur
cur -> rlink = temp
return head
}

Void search(NODE head)
{
    NODE ptr
    int item, i=0, flag;
    ptr = head;
    if (ptr == NULL)
    {
        printf("Empty list\n");
    }
    else
    {
        printf("Enter item to search\n");
        Scanf("%d", & item);
        while (ptr != NULL)
        {
            if (ptr -> info == item)
            {
                printf("Item found at %d\n", i);
                flag = 0;
                break
            }
            else
```

```
        {
            flag = 1
        {
        i++;
        ptr = ptr -> rlink
    }
if (flag == 1)
{
    printf("\nItem not found\n");
    break;
}
```

```
NODE delete_all(int item, NODE head)
{
    NODE prev, cur, next;
    int count;
    if(head -> rlink == head)
    {
        printf("Empty\n");
        return head;
    }
    count = 0;
    cur = head -> rlink;
    while(cur != head)
    {
        if(item != cur -> info)
            cur = cur -> rlink;
        else
        {
            count++;
            prev = cur -> llink;
            next = cur -> rlink;
            prev -> rlink = next;
            next -> llink = prev;
            free(cur);
            cur = next;
        }
    }
    if(count == 0)
        printf("Not found\n");
    else
        printf("Key found at %d position\n", count);
    return head;
}
```

```
int main()
{
    NODE head, last
    int item, choice
    head = getnode()
    head->rlink = head
    head->llink = head
    for(;;)
    {
        printf("1: Insert front\n");
        printf("2: Insert Rear\n");
        printf("3: Delete front\n");
        printf("4: DeleteRear\n");
        printf("5: display\n");
        printf("6: insert_left\n");
        printf("7: RemoveDuplicates\n");
        printf("8: search\n");
        printf("9: insertRight\n");
        printf("10: exit\n");
        printf("Enter your choice\n");
        scanf("%d", &choice)
        switch(choice)
        {
            case 1: printf("Enter item\n");
                    scanf("%d", &item);
                    last = dinsert_front(item, head);
                    break

            case 2: printf("Enter item\n");
                    scanf("%d", &item);
                    last = insert_end(item, head);
                    break;
```

```
case 3: last = delete_front (head);
        break;

case 4: last = delete_rear(head);
        break;

case 5: display(head)
        break;

case 6: printf("Enter the item\n");
        scanf("%d", &item);
        head = insert_leftpos(item, head);
        break;

case 7: printf("Enter the item\n");
        scanf("%d", &item);
        head = delete_all_key(item, head);
        break;

case 8: search(head);
        break;

case 9: printf("Enter item\n");
        scanf("%d", &item);
        head = insert_rightpos(item, head);
        break;

    default: exit(0);

}
}
```

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Binary Search Tree

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

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

NODE getnode (int data)
{
    NODE x = (NODE) malloc(sizeof
                (struct node));

    x -> data = data;
    x -> right = NULL;
    x -> left = NULL;

}
```

```
NODE insert (NODE root, int info)
{
    NODE new_node = getnode(info)
    if (new
    {

    if (root == NULL)
        NODE new_node = getnode(info)

else if (root -> data <= info)
        root -> right = insert(root
                               -> right, info

else
    root -> left = insert(root -> left, inf
);
}
```

```
Void preorder(NODE root)
{ if (root != NULL) {
    printf("%d\t", root->data);
    preorder(root->left);
    preorder(root->right);
  }
}

Void postorder(NODE root)
{
    if (root == NULL)
        return

    postorder(root->left);
    postorder(root->right);
}
```

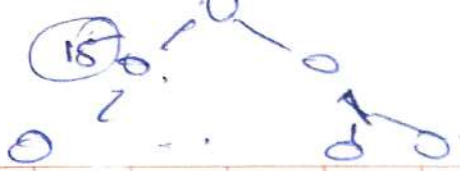
```
void inorder (NODE root)
{
    if (root == NULL)
        return

    inorder (root -> left);
    printf ("%d ", root -> data);
    inorder (root -> right);
}
NODE delete_newnode (NODE root, data);
{
    if (root == NULL)
        return root
else if (info < root -> data)
        root -> left = delete_newnode
                        (root -> left data

else if (info > root -> data
        root -> right = delete-newnode
                        (root -> right,
                        data)

else
```

```
if (root -> right == NULL &&
{
    NODE temp = root;
    free(temp);
    root == NULL;
    return true;
}
else if (root -> right == NULL)
{
    NODE temp = root;
    free(temp);
    root = root -> right;
    return root;
}
else if (left -> right == NULL)
{
    NODE temp = root;
    free(temp)
    root = root -> right;
    return root
}
```



Page No.
Date / /

root -> left == NULL)

else
{

NODE temp = findmin(root -> right)

root -> data = temp -> data;
root -> right = delete
(root -> right-
, temp -> d

}
}return root

{

```
void display(NODE root, int i)
{
    if (root == NULL)
        return

    display(root->right, i+1);
    for(int j=1; j<=i; j++)
        printf(" ");
    printf("%d\n", root->data);
    display(root->left, i+1);
    display(root->left, i+1);

}

int height(NODE root)
{
    if (root == NULL)
        return -1;
    int left_height = height(root->left);
    int right_height = height(root->right);
    int val = max(left_height, right_height);
    return val + 1;
}
```

Page No.
Date / /

getleafCount(NODE root)

```
int leafCount(NODE root)
{
    if (root == NULL)
        return 0;
    if (root->right == NULL && root->left == NULL)
        return 1
    else
        return (getCount(root->right) + getLeafCount(root->left));
}
```

```
int main()
{
    printf("1:insert
do {
    NODE root = NULL;
    int option, data;
    printf("1: insert \n");
    printf("2: Delete \n");
    printf("3: Preorder\n");
    printf("4: Postorder\n");
    printf("5: inorder \n");
    printf("6: display\n");
    printf("Enter your option");
    Scanf("%d", &option);
    switch(option)
    {
        case 1:
            printf("Enter data\n");
            Scanf("%d", &data);
            root = insert(root, data);
            break;

        case 2:
            printf("enter data\n");
            Scanf("%d", &data);
```

```
            root = delete_node(root, data);
            break;

        case 3:
            preorder(root);
            break;

        case 4:
            postorder(root);
            break;

        case 5:
            inorder(root);
            break;

        case 6:
            display(root);
            break;
        }
);  } while(option != 7);
    }
}
```

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```
#include<stdio.h>
#include<string.h>
#include<stdlib.h>
struct node
{
   int info
   struct node *llink;
   struct node *rlink;
};
typedef struct node *NODE
NODE getnode()
{
    NODE x;
    x = (NODE) malloc (sizeof(struct node));
    if (x==NULL)
    {
       printf("Memory not available");
       exit(0);
    }
```

```
return x;

NODE insert(int item, NODE root)
{
    NODE temp, cur, prev;
    char direction[10];
    int i;
    temp = getnode();
    temp->info = item;
    temp->llink = NULL;
    temp->rlink = NULL;
    if(root == NULL)
        return temp
    printf("Give direction to insert\n");
    scanf("%s", direction);
    prev = NULL;
    cur = root;
    for(i=0; i< strlen(direction) &&
                cur != NULL;
                i++)
    {
        prev = cur;
        if(direction[i] == 'l')
            cur = cur->llink;
        else
```

```
cur = cur -> rlink
}
if ( cur != NULL || i != strlen(direction)
    printf("insertion not possible");
    free(temp);
    return(root);
{
if (cur == NULL)
    if (direction[i-1] == 'l')
        prev -> llink = temp
    else
        prev -> rlink = temp
;
return(root);
}
```

```
void preorder(NODE root)
{
  if (root != NULL)
  {
    printf("Item is %d\n", root->info);
    preorder (root -> llink);
    preorder (root -> rlink);
  }
}

void inorder (NODE root)
{
  if (root != NULL)
  {
    inorder (root -> llink);
    printf ("Item is %d\n", root->info);
    inorder (root -> rlink);
  }
}
```

```
void postorder(NODE root)
{
    if(root != NULL)
    {
        postorder(root->llink);
        postorder(root->rlink);
        printf("Item is %d\n", root
                                ->info);
    }
}

void display(NODE root, int i)
{
    int j;
    if(root != NULL)
    {
        display(root->rlink, i+1);
        for(j=1; j<=i; j++)
            printf("  ");
        printf("%d\n", root->info);
        display(root->llink, i+1);
    }
}
```

```
void main()
{
    NODE root = NULL
    int choice, i, item
    for(;;)
    {
        printf("1: insert\n");
        printf("2: preorder\n");
        printf("3: inorder\n");
        printf("4: postorder\n");
        printf("5: Display\n");
        Scanf("%d", &choice);
switch (choice)
{
    case1:  printf("Enter item\n")
            Scanf("%d", &item);
            root = insert(item, root);
            break;

    case 2: if (root == NULL)
            {
                printf("tree empty\n");
            }
```

```
else
{
    printf("Given tree is");
    display(root, 1);
    printf("Preorder traversal\n");
    preorder(root);
}

break;

case 3: if(root==NULL)
{
    printf("Tree empty\n");
}
else
{
    printf("Given Tree is");
    display(root, 1);
    printf("In order traversal\n");
    inorder(root);
}
break;
```

```
case 4: if (root == NULL)
        {
            printf("\nTree empty\n");
        }
        else
        {
            printf("\nEnter tree is");
            display(root, 1);
            printf("\n postorder traversal\n");
            postorder(root);
        }
        break;

case 5: display(root, 1);
        break;

default: exit(0);
    }
}
```