Program 1

AIM:-Write a program to perform Binary Search Tree(BST)

```
#include<stdio.h>
#include<malloc.h>
#include<stdlib.h>
struct tree{
        int data;
        struct tree *right;
        struct tree *left;
};
struct tree *root;
void create()
{
 int n,i,item;
 struct tree *p,*q;
 printf("enter the no of nodes:");
 scanf("%d",&n);
 for(i=0;i<n;i++)
 {
 p=(struct tree *)malloc(sizeof(struct tree));  printf("enter item:");
 scanf("%d",&item);
 p->data=item;
 p->left=NULL;
 p->right=NULL;
 if(i==0)
 root=p;
 else
 {
 q=root;
```

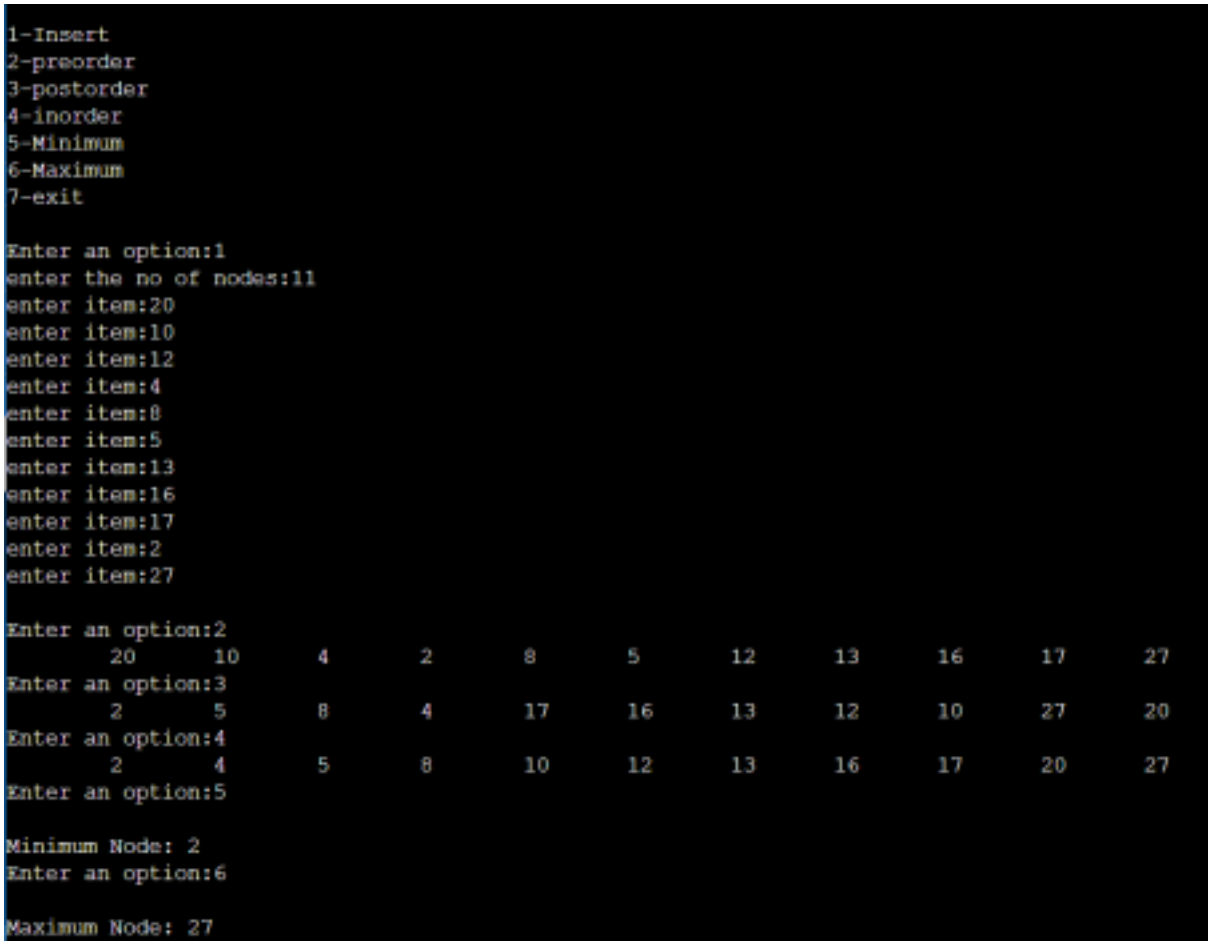
```
 while(1)
 {
 if(p->data>q->data)  {
 if(q->right==NULL)  {
 q->right=p;  break;
 }
 else
 {
 q=q->right;  }
 }
 else
 {
 if(q->left==NULL)  {
 q->left=p;  break;
 }
 else
 {
 q=q->left;
 }
 }
 }
 }
 }
}

void preorder(struct tree *temp) {
        struct tree *t=temp;
```

```
	if(t==NULL)
		return;
	else{
		printf("\t%d",t->data);
		preorder(t->left);
		preorder(t->right);
	}
}
void postorder(struct tree *temp) {
	struct tree *t=temp;
	if(t==NULL)
		return;
	else{
		postorder(t->left);
		postorder(t->right);
		printf("\t%d",t->data);
	}
}
void inorder(struct tree *temp) {
	struct tree *t=temp;
	if(t==NULL)
		return;
	else{
		inorder(t->left);
		printf("\t%d",t->data);
		inorder(t->right);
	}
}
```

```
   void min(struct tree *temp){ struct
                tree *t=temp;
          if(t==NULL)
                return;
          else{
                while(t->left!=NULL){
                      t=t->left;
                }
          }
          printf("\nMinimum Node: %d",t->data);
}
void max(struct tree *temp){
          struct tree *t=temp;
          if(t==NULL)
                return;
          else{
                while(t->right!=NULL){
                      t=t->right;
                }
          }
          printf("\nMaximum Node: %d",t->data);
}
void main()
{
 int opt;
          do{
           printf("\n1-Insert\n2-preorder\n3-postorder\n4-inorder\n5- Minimum\n6-
Maximum\n7-exit\nEnter choice; ");
                scanf("%d",&opt);
```

```
            switch(opt){
                case 1:create();break;
                case 2:preorder(root);break;
                case 3:postorder(root);break;
                case 4:inorder(root);break;
                case 5:min(root);break;
                case 6:max(root);break;
                case 7:exit(0);break;
                        default:printf("\nInvalid Choice");break;
            }
        }while(opt!=7);
}
```

OUTPUT:-



PROGRAM 2

AIM:-Write a program to perform Red Black Tree(RBT) operation.

```
#include <stdio.h>
#include <stdlib.h>
enum nodeColor {
  RED,
  BLACK
};
struct rbNode {
  int data, color;
  struct rbNode *link[2];
};
struct rbNode *root = NULL;
// Create a red-black tree
   struct rbNode *createNode(int data) {
  struct rbNode *newnode;
  newnode = (struct rbNode *)malloc(sizeof(struct rbNode));
  newnode->data = data;
  newnode->color = RED;
  newnode->link[0] = newnode->link[1] = NULL;
  return newnode;
}
// Insert an node
   void insertion(int data) {
  struct rbNode *stack[98], *ptr, *newnode, *xPtr, *yPtr;
  int dir[98], ht = 0, index;
  ptr = root;
  if (!root) {
    root = createNode(data);
    return;
  }

  stack[ht] = root;
  dir[ht++] = 0;
  while (ptr != NULL) {
    if (ptr->data == data) {
      printf("Duplicates Not Allowed!!\n");
      return;
    }
    index = (data - ptr->data) > 0 ? 1 : 0;
    stack[ht] = ptr;
    ptr = ptr->link[index];
    dir[ht++] = index;
  }
  stack[ht - 1]->link[index] = newnode = createNode(data);
  while ((ht >= 3) && (stack[ht - 1]->color == RED)) {
    if (dir[ht - 2] == 0) {
      yPtr = stack[ht - 2]->link[1];
      if (yPtr != NULL && yPtr->color == RED) {
        stack[ht - 2]->color = RED;
        stack[ht - 1]->color = yPtr->color = BLACK;
        ht = ht - 2;
      } else {
```

```
        if (dir[ht - 1] == 0) {
          yPtr = stack[ht - 1];
        } else {
          xPtr = stack[ht - 1];
          yPtr = xPtr->link[1];
          xPtr->link[1] = yPtr->link[0];
          yPtr->link[0] = xPtr;
          stack[ht - 2]->link[0] = yPtr;
        }
        xPtr = stack[ht - 2];
        xPtr->color = RED;
        yPtr->color = BLACK;
        xPtr->link[0] = yPtr->link[1];
        yPtr->link[1] = xPtr;
        if (xPtr == root) {
          root = yPtr;
        } else {
          stack[ht - 3]->link[dir[ht - 3]] = yPtr;
        }
        break;
      }
    } else {
      yPtr = stack[ht - 2]->link[0];
      if ((yPtr != NULL) && (yPtr->color == RED)) {
        stack[ht - 2]->color = RED;
        stack[ht - 1]->color = yPtr->color = BLACK;
        ht = ht - 2;
      } else {
        if (dir[ht - 1] == 1) {
          yPtr = stack[ht - 1];
        } else {
          xPtr = stack[ht - 1];
          yPtr = xPtr->link[0];
          xPtr->link[0] = yPtr->link[1];
          yPtr->link[1] = xPtr;
          stack[ht - 2]->link[1] = yPtr;
        }
        xPtr = stack[ht - 2];
        yPtr->color = BLACK;
        xPtr->color = RED;
        xPtr->link[1] = yPtr->link[0];
        yPtr->link[0] = xPtr;
        if (xPtr == root) {
          root = yPtr;
        } else {
          stack[ht - 3]->link[dir[ht - 3]] = yPtr;
        }
        break;
      }
    }
  }
  root->color = BLACK;
}
// Delete a node
   void deletion(int data) {
```

```
struct rbNode *stack[98], *ptr, *xPtr, *yPtr;
struct rbNode *pPtr, *qPtr, *rPtr;
int dir[98], ht = 0, diff, i;
enum nodeColor color;

if (!root) {
  printf("Tree not available\n");
  return;
}

ptr = root;
while (ptr != NULL) {
  if ((data - ptr->data) == 0)
    break;
  diff = (data - ptr->data) > 0 ? 1 : 0;
  stack[ht] = ptr;
  dir[ht++] = diff;
  ptr = ptr->link[diff];
}

if (ptr->link[1] == NULL) {
  if ((ptr == root) && (ptr->link[0] == NULL)) {
    free(ptr);
    root = NULL;
  } else if (ptr == root) {
    root = ptr->link[0];
    free(ptr);
  } else {
    stack[ht - 1]->link[dir[ht - 1]] = ptr->link[0];
  }
} else {
  xPtr = ptr->link[1];
  if (xPtr->link[0] == NULL) {
    xPtr->link[0] = ptr->link[0];
    color = xPtr->color;
    xPtr->color = ptr->color;
    ptr->color = color;

    if (ptr == root) {
      root = xPtr;
    } else {
      stack[ht - 1]->link[dir[ht - 1]] = xPtr;
    }

    dir[ht] = 1;
    stack[ht++] = xPtr;
  } else {
    i = ht++;
    while (1) {
      dir[ht] = 0;
      stack[ht++] = xPtr;
      yPtr = xPtr->link[0];
      if (!yPtr->link[0])
        break;
      xPtr = yPtr;
```

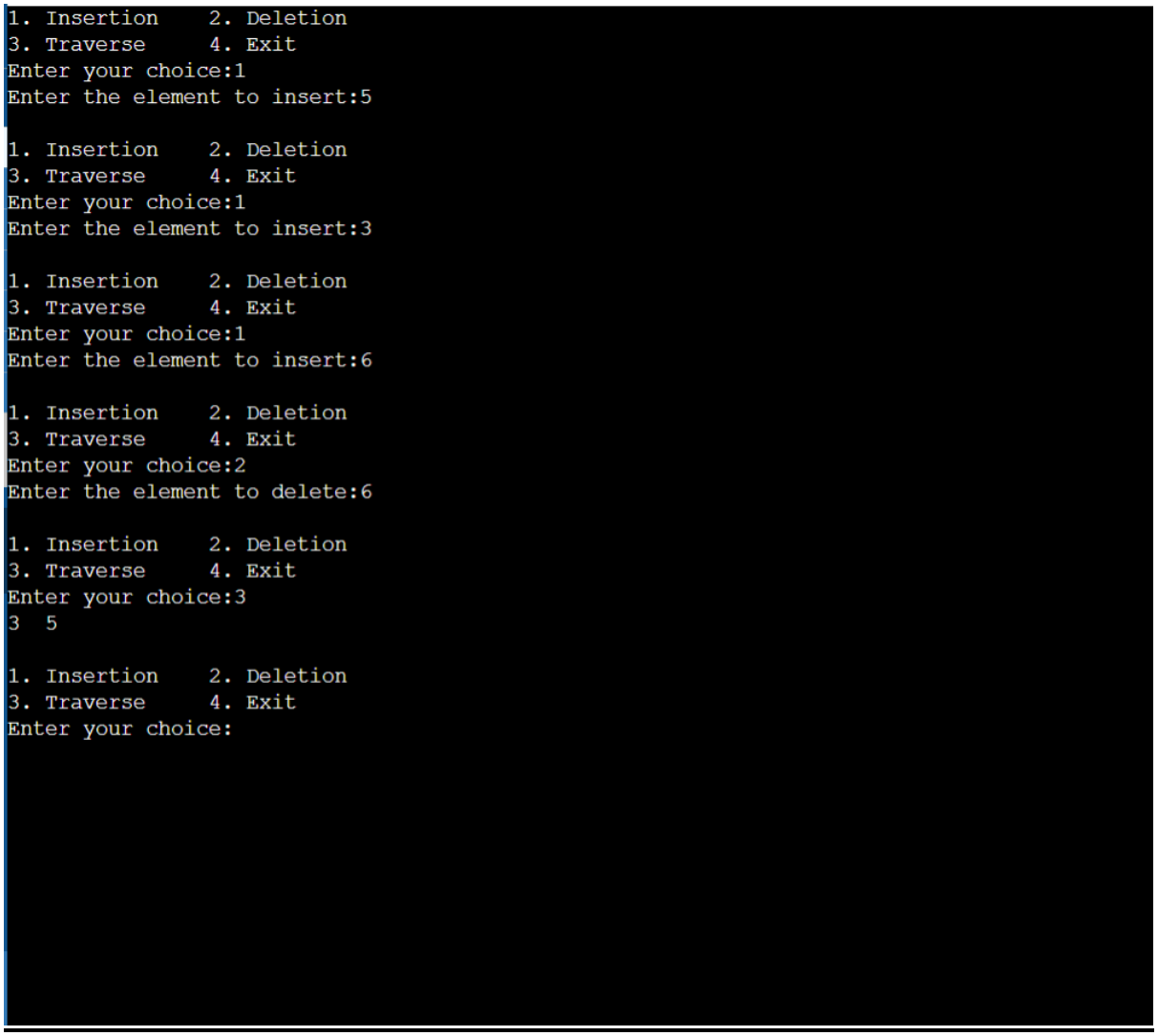
```
    }

    dir[i] = 1;
    stack[i] = yPtr;
    if (i > 0)
      stack[i - 1]->link[dir[i - 1]] = yPtr;

    yPtr->link[0] = ptr->link[0];

    xPtr->link[0] = yPtr->link[1];
    yPtr->link[1] = ptr->link[1];

    if (ptr == root) {
      root = yPtr;
    }

    color = yPtr->color;
    yPtr->color = ptr->color;
    ptr->color = color;
  }
}

if (ht < 1)
  return;

if (ptr->color == BLACK) {
  while (1) {
    pPtr = stack[ht - 1]->link[dir[ht - 1]];
    if (pPtr && pPtr->color == RED) {
      pPtr->color = BLACK;
      break;
    }

    if (ht < 2)
      break;

    if (dir[ht - 2] == 0) {
      rPtr = stack[ht - 1]->link[1];

      if (!rPtr)
        break;

      if (rPtr->color == RED) {
        stack[ht - 1]->color = RED;
        rPtr->color = BLACK;
        stack[ht - 1]->link[1] = rPtr->link[0];
        rPtr->link[0] = stack[ht - 1];

        if (stack[ht - 1] == root) {
          root = rPtr;
        } else {
          stack[ht - 2]->link[dir[ht - 2]] = rPtr;
        }
        dir[ht] = 0;
        stack[ht] = stack[ht - 1];
```

```
      stack[ht - 1] = rPtr;
      ht++;

      rPtr = stack[ht - 1]->link[1];
    }

    if ((!rPtr->link[0] || rPtr->link[0]->color == BLACK) &&
      (!rPtr->link[1] || rPtr->link[1]->color == BLACK)) {
      rPtr->color = RED;
    } else {
      if (!rPtr->link[1] || rPtr->link[1]->color == BLACK) {
        qPtr = rPtr->link[0];
        rPtr->color = RED;
        qPtr->color = BLACK;
        rPtr->link[0] = qPtr->link[1];
        qPtr->link[1] = rPtr;
        rPtr = stack[ht - 1]->link[1] = qPtr;
      }
      rPtr->color = stack[ht - 1]->color;
      stack[ht - 1]->color = BLACK;
      rPtr->link[1]->color = BLACK;
      stack[ht - 1]->link[1] = rPtr->link[0];
      rPtr->link[0] = stack[ht - 1];
      if (stack[ht - 1] == root) {
        root = rPtr;
      } else {
        stack[ht - 2]->link[dir[ht - 2]] = rPtr;
      }
      break;
    }
  } else {
    rPtr = stack[ht - 1]->link[0];
    if (!rPtr)
      break;

    if (rPtr->color == RED) {
      stack[ht - 1]->color = RED;
      rPtr->color = BLACK;
      stack[ht - 1]->link[0] = rPtr->link[1];
      rPtr->link[1] = stack[ht - 1];

      if (stack[ht - 1] == root) {
        root = rPtr;
      } else {
        stack[ht - 2]->link[dir[ht - 2]] = rPtr;
      }
      dir[ht] = 1;
      stack[ht] = stack[ht - 1];
      stack[ht - 1] = rPtr;
      ht++;

      rPtr = stack[ht - 1]->link[0];
    }
    if ((!rPtr->link[0] || rPtr->link[0]->color == BLACK) &&
      (!rPtr->link[1] || rPtr->link[1]->color == BLACK)) {
```

```
          rPtr->color = RED;
        } else {
          if (!rPtr->link[0] || rPtr->link[0]->color == BLACK) {
            qPtr = rPtr->link[1];
            rPtr->color = RED;
            qPtr->color = BLACK;
            rPtr->link[1] = qPtr->link[0];
            qPtr->link[0] = rPtr;
            rPtr = stack[ht - 1]->link[0] = qPtr;
          }
          rPtr->color = stack[ht - 1]->color;
          stack[ht - 1]->color = BLACK;
          rPtr->link[0]->color = BLACK;
          stack[ht - 1]->link[0] = rPtr->link[1];
          rPtr->link[1] = stack[ht - 1];
          if (stack[ht - 1] == root) {
            root = rPtr;
          } else {
            stack[ht - 2]->link[dir[ht - 2]] = rPtr;
          }
          break;
        }
      }
      ht--;
    }
  }
}
// Print the inorder traversal of the tree
void inorderTraversal(struct rbNode *node) {
  if (node) {
    inorderTraversal(node->link[0]);
    printf("%d  ", node->data);
    inorderTraversal(node->link[1]);
  }
  return;
}

int main() {
  int ch, data;
  while (1) {
    printf("1. Insertion\t2. Deletion\n");
    printf("3. Traverse\t4. Exit");
    printf("\nEnter your choice:");
    scanf("%d", &ch);
    switch (ch) {
      case 1:
        printf("Enter the element to insert:");
        scanf("%d", &data);
        insertion(data);
        break;
      case 2:
        printf("Enter the element to delete:");
        scanf("%d", &data);
        deletion(data);
        break;
```

```
      case 3:
        inorderTraversal(root);
        printf("\n");
        break;
      case 4:
        exit(0);
      default:
        printf("Not available\n");
        break;
    }
    printf("\n");
  }
  return 0;
}
```

OUTPUT:-



PROGRAM 3

AIM:-Write a program to perform Binary tree(Btree) operation.

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

#define MAX 3
#define MIN 2

struct BTreeNode
{
  int val[MAX + 1], count;
  struct BTreeNode *link[MAX + 1];
};

struct BTreeNode *root;
struct BTreeNode *createNode(int val, struct BTreeNode *child) { struct BTreeNode
  *newNode;
  newNode = (struct BTreeNode *)malloc(sizeof(struct BTreeNode)); newNode->val[1] =
  val;
  newNode->count = 1;
  newNode->link[0] = root;
  newNode->link[1] = child;
  return newNode;
}
void insertNode(int val, int pos, struct BTreeNode *node, struct BTreeNode *child) {
  int j = node->count;
  while (j > pos) {
    node->val[j + 1] = node->val[j];
    node->link[j + 1] = node->link[j];
    j--;
  }
  node->val[j + 1] = val;
  node->link[j + 1] = child;
  node->count++;
}
void splitNode(int val, int *pval, int pos, struct BTreeNode *node, struct BTreeNode *child,
  struct BTreeNode **newNode) { int median, j;

  if (pos > MIN)
    median = MIN + 1;
  else
    median = MIN;
  *newNode = (struct BTreeNode *)malloc(sizeof(struct BTreeNode)); j = median + 1;
  while (j <= MAX) {
    (*newNode)->val[j - median] = node->val[j];
    (*newNode)->link[j - median] = node->link[j];
    j++;
```

```
  }
  node->count = median;
  (*newNode)->count = MAX - median;

  if (pos <= MIN) {
    insertNode(val, pos, node, child);
  } else {
    insertNode(val, pos - median, *newNode, child);
  }
  *pval = node->val[node->count];
  (*newNode)->link[0] = node->link[node->count];
  node->count--;
}
int setValue(int val, int *pval,
          struct BTreeNode *node, struct BTreeNode **child) { int pos;
  if (!node) {
    *pval = val;
    *child = NULL;
    return 1;
  }

  if (val < node->val[1]) {
    pos = 0;
  } else {
    for (pos = node->count;
       (val < node->val[pos] && pos > 1); pos--)
      ;
    if (val == node->val[pos]) {
      printf("Duplicates are not permitted\n");
      return 0;
    }
  }
  if (setValue(val, pval, node->link[pos], child)) {
    if (node->count < MAX) {
      insertNode(*pval, pos, node, *child);
    } else {
      splitNode(*pval, pval, pos, node, *child, child); return 1;
    }
  }
  return 0;
}
void insert(int val) {
  int flag, i;
  struct BTreeNode *child;

  flag = setValue(val, &i, root, &child);
  if (flag)
```

```
      root = createNode(i, child);
  }
void search(int val, int *pos, struct BTreeNode *myNode) { if (!myNode) {
      return;
    }

    if (val < myNode->val[1]) {
      *pos = 0;
    } else {
      for (*pos = myNode->count;
         (val < myNode->val[*pos] && *pos > 1); (*pos)--) ;
      if (val == myNode->val[*pos]) {
        printf("%d is found", val);
        return;
      }
    }
    search(val, pos, myNode->link[*pos]);

    return;
  }

void traversal(struct BTreeNode *myNode) { int i;
    if (myNode) {
      for (i = 0; i < myNode->count; i++) {
        traversal(myNode->link[i]);
        printf("%d ", myNode->val[i + 1]);
      }
      traversal(myNode->link[i]);
    }
  }

  int main() {
    int val, ch;

    insert(8);
    insert(9);
    insert(10);
    insert(11);
    insert(15);
    insert(16);
    insert(17);
    insert(18);
    insert(20);
    insert(23);

    traversal(root);
```

```
printf("\n");
search(11, &ch, root); }
```

OUTPUT:-