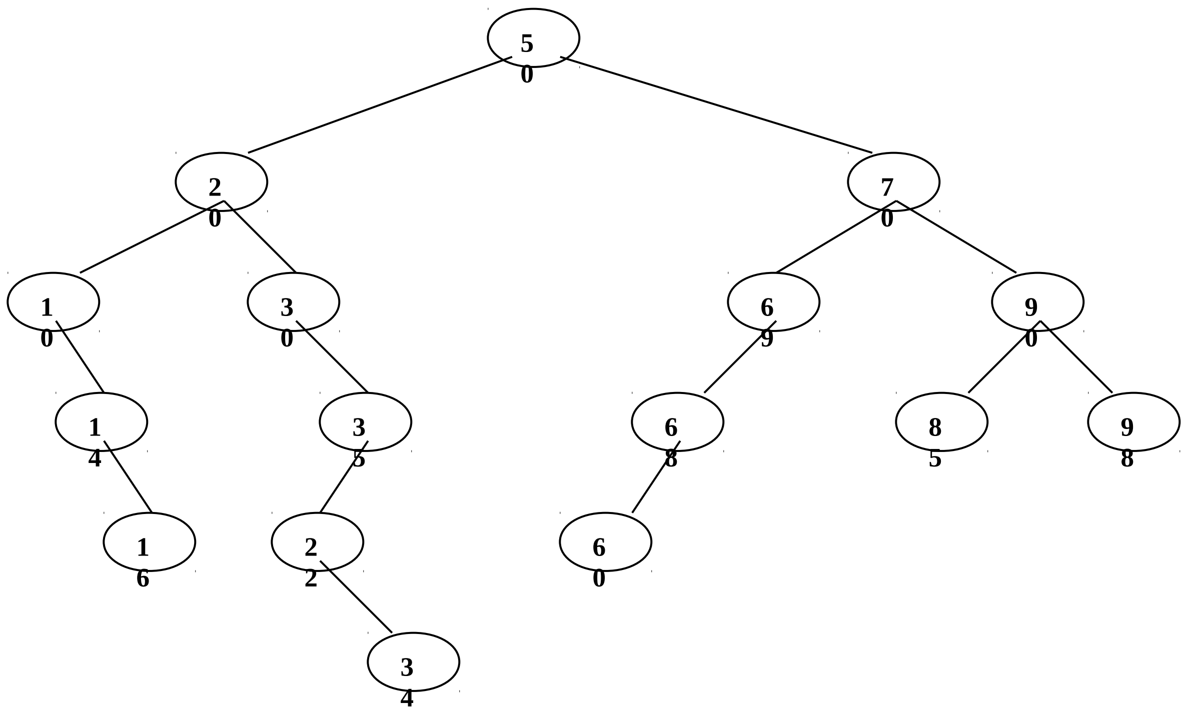


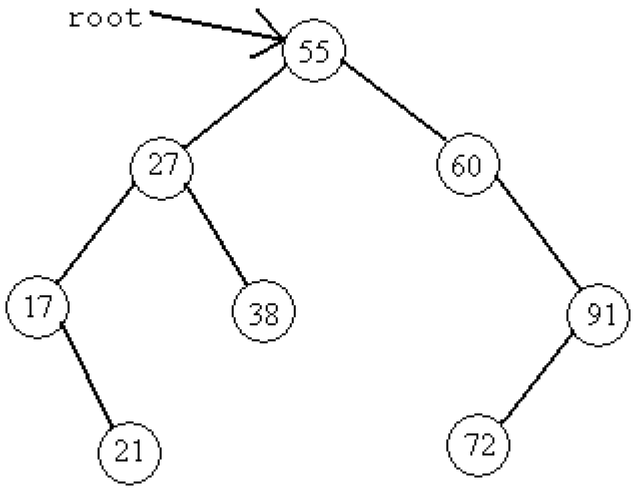
(c) Execute the algorithm shown below using the tree shown above. Show the exact output produced by the algorithm. Assume that the initial call is: **prob3(root)** and that the tree nodes and pointers are defined as shown.

```
struct treeNode{
     int data;
        struct treeNode *left, *right;
}
struct treeNode *tree_ptr;

void prob3(struct tree_ptr *node_ptr) {
   if (node_ptr != NULL){
        if (node_ptr->data % 3 == 0){
             printf(“%d “, node_ptr->data);
             prob3(node_ptr->left);
        }
        else{
             if (node_ptr->data % 3 == 1){
                  printf(“%d “, node_ptr->data+2);
                  prob3(node_ptr->right);
             }
             else{
                  if (node_ptr->data % 3 == 2){
                       prob3(node_ptr->left);
                       prob3(node_ptr->right);
                  }
             }
        }
   }
  }
```

Output:

12	**18**	**30**	**72**	**90**	**87**					

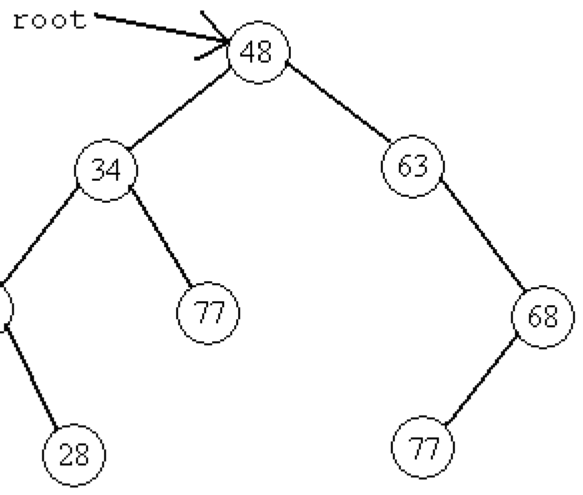
1. **[9 pts]** For the binary tree given below **`root`** is a pointer to the root of the tree.



Redraw (on the following page) the tree shown above when the following function is executed. Assume that the initial call is `modifyT(root, 7, 65).`

```
struct treeNode
{
   int data;
   struct treeNode *left;
   struct treeNode *right;
};

void modifyT(struct treeNode* node_ptr, int key, int num)
{
   if (node_ptr != NULL)
   {
      if (node_ptr->data % 3 == 0)
      {
         node_ptr->data += key;
         modifyT(node_ptr->left, key + 2, num - key);
         modifyT(node_ptr)->right, key – 3, num + key);
      }
      else if (node_ptr->data % 5 == 0)
      {
         node_ptr->data -= key;
         modifyT(node_ptr->right, key - 4, num);
         modifyT(node_ptr->left, key, num + 5);
      }
      else
      {
         node_ptr->data = num;
         modifyT(node_ptr->right, key - 2, num + 10);
         modifyT(node_ptr->left, key + 5, num – 7);
      }
   }
}
```

Answer for Problem 3



1 point for each correct node modification
1 point extra if the entire tree is correct

5. **[8 pts]** Write a recursive function that compares two given binary trees. It returns 1 if two trees are different and it returns 0 otherwise. Use the node structure and the function prototype provided below:

```
struct treeNode {
      int data;
      struct treeNode * left;
      struct treeNode * right;
};

int check(struct treeNode *A, struct treeNode *B)
```

One possible solution:

```
int check(struct treeNode *A, struct treeNode *B)
{
      if(A == NULL && B == NULL)
            return 0;
      else if(A == NULL || B == NULL)
            return 1;
      else if(a->data != b->data)
            return 1;

      if(check(A->left, B->left) || check(A->right, B->right))
            return 1;
      else
            return 0;
}
```

Grading:
Base cases:
The trees are the same if both trees are NULL (1 point)
The trees are different if one is NULL, the other isn't (1 point)
The trees are different if neither is NULL, but the data differs (1 point)

Recursive cases:
The two trees are different if either the left or right is different (3 points)
The two trees are the same only if both the left and right are the same (2 points)

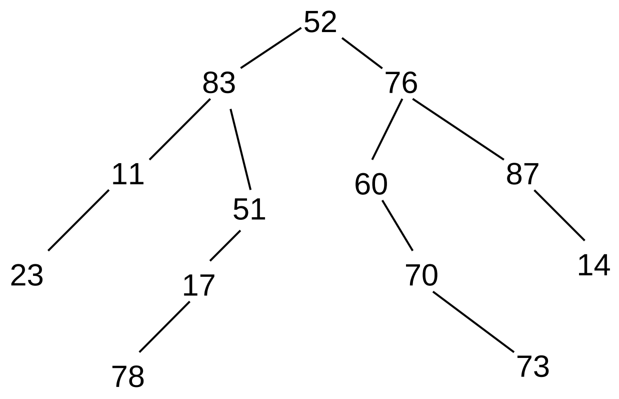
5. **a) [5 pts]** Indicate in few words, the purpose of the following function. The struct treenode is the same as the one defined in problem 4 on the previous page.

```
int f(struct treenode * p) {

    int val;
    if (p == NULL) return 0;
    val = p->data;
    if (val%2 == 0)
        return val + f(p->left) + f(p->right);
    else
        return f(p->left) + f(p->right);

}
```

Returns the sum of the nodes storing even values in the tree.

Grading: 2 pts for sum, 1 pt for node values, 2 pts for even

b) **[5 pts]** What does the function return, given the following tree?



Answer: **78+52+76+60+70+14 = 350**

3. (10 points) Write a recursive function to compute the height of a tree, defined as the length of the longest path from the root to a leaf node. For the purposes of this problem a tree with only one node has height 1 and an empty tree has height 0. Your function should make use of the following tree node structure:

```
struct treenode {
     int data;
     struct treenode* left;
     struct treenode* right;
};

int height(struct treenode* root)
{
     int leftheight, rightheight;

     if(root == NULL)
          return 0;

     leftheight = height(root->left);
     rightheight = height(root->right);

     if(leftheight > rightheight)
          return leftheight + 1;

     return rightheight + 1;









}
```

3. Write a recursive function **struct node * largest(struct node * B)** which returns a pointer to the node containing the largest element in a BST (binary search tree). The node structure is as follows:

```
struct node {
     int node_value;
     struct node * left, *right;
};
```

[8 pts]

```
struct node* largest(struct node *B){
        if ( B==NULL)
                return NULL;
        else if (B->right ==NULL)
                return B;
        else return largest(B->right);
}
```

Grading: 4 pts for an iterative solution

4. In a binary tree, each node may have a single child, two children, or no child. Write a recursive function **`int one (struct tree_node *p)`** for a binary tree which returns the number of nodes with a single child.
Use the node structure

```
struct tree_node {
     int data;
     struct tree_node * left, *right;
};
```

[10 pts]

```
int one  ( struct tree_node *p){
        if ( p != NULL)
         {
                if( p->left == NULL)
                        if( p->right != NULL)
                                return 1+ one(p->right);
                else if( p->right == NULL)
                         if( p->left != NULL)
                                return 1+ one(p->left);
        else
                return one (p->left) + one(p->right) ;
    }
}
```

5. The following code is applied on the tree shown below with p pointing to the root of the tree. Show each change on the tree by crossing out the old value and replacing with the new value.

[14 pts]

```
struct node {
     int data;
     struct node * left, *right:
};
func( struct node *p)
{
     if ( p == null)
          return;
     func(p ->right);
     func( p->left);
     if (p->right != null)
          p ->data = p ->right -> data;

     if (p->left != null)
          p ->data = (p ->left -> data)/2;

}
```

Grading : One point for each change in value