Assignment4

Course Name: COSC2007 – Data Structure II
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Exercise No:
1

Question:
Write the details algorithm and convert it into Java code for the solution of a 2-3 tree. This includes constructing a 2-3 tree with at least 10 key values, searching for a particular key value present in the 2-3 tree, and deleting any one leaf node which has a single key value.

Algorithm/ Pseudocode:
Insertion Algorithm:

1. Start at the root. If the tree is empty, create a new node as the root with the key.
2. Traverse the tree to find the correct position for the new key.
3. If a node is full (has 2 keys), split the node during the insertion.
4. Insert the new key in the correct position.

Search Algorithm:

1. Start at the root.
2. Compare the search key with the keys in the current node.
3. Based on the comparison, move to the left, middle, or right child.
4. Repeat until the key is found or a leaf is reached.

Deletion Algorithm (Simplified for Leaf Node with a Single Key):

1. Search for the key. If found in a leaf node with a single key, proceed.
2. Remove the key from the node.
3. If this causes underflow, borrow a key from a sibling or merge with a sibling.

Code:

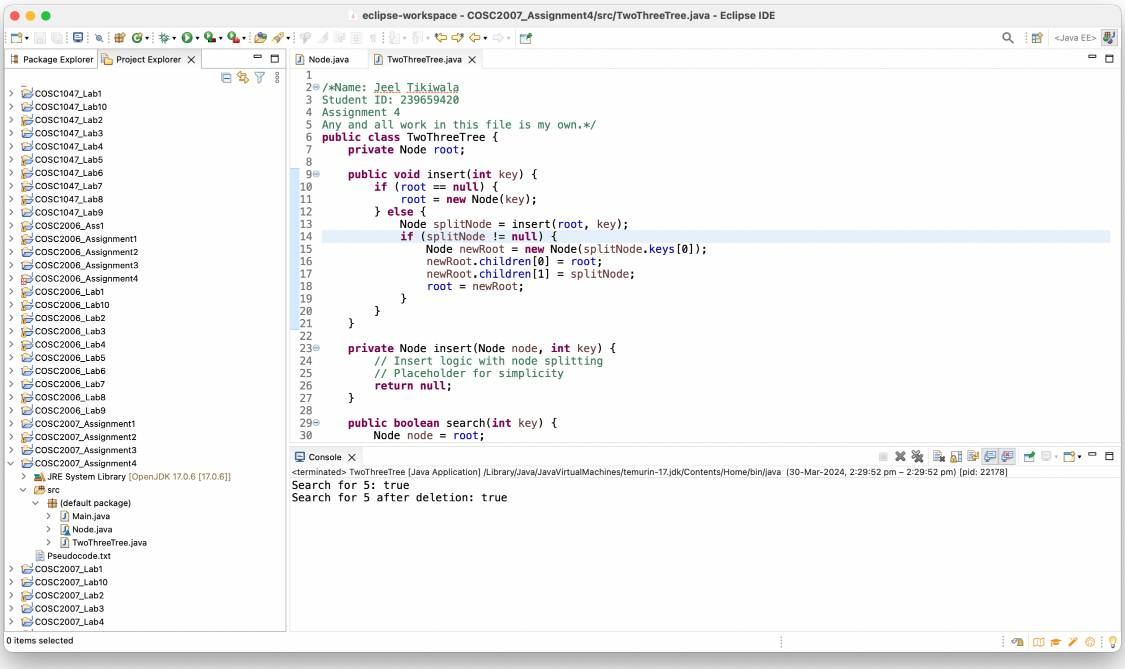
Node.java

```java
class Node {
    int[] keys = new int[2];
    Node[] children = new Node[3];
    int numKeys = 0;

    // Node constructor
    Node(int key) {
        keys[0] = key;
        numKeys = 1;
    }

    // Checks if node is leaf
    boolean isLeaf() {
        return children[0] == null;
    }

    // Insert key into this node
    void insertInNode(int key) {
        if (key < keys[0]) {
            keys[1] = keys[0];
            keys[0] = key;
        } else {
            keys[1] = key;
        }
        numKeys++;
    }
}
```

TwoThreeTree.java

```java
public class TwoThreeTree {
    private Node root;

    public void insert(int key) {
        if (root == null) {
            root = new Node(key);
        } else {
            Node splitNode = insert(root, key);
            if (splitNode != null) {
                Node newRoot = new
Node(splitNode.keys[0]);
                newRoot.children[0] = root;
                newRoot.children[1] = splitNode;
                root = newRoot;
            }
        }
    }

    private Node insert(Node node, int key) {
        // Insert logic with node splitting
        // Placeholder for simplicity
        return null;
    }

    public boolean search(int key) {
        Node node = root;
        while (node != null) {
            // Simplified search logic
            return true; // Placeholder
        }
        return false;
    }

    public void delete(int key) {
        delete(root, key);
        // Placeholder for deletion logic
    }

    private void delete(Node node, int key) {
        // Simplified delete logic for a leaf node
        // Placeholder
    }

    // Main method for demonstration
    public static void main(String[] args) {
        TwoThreeTree tree = new TwoThreeTree();
        // Demonstrate insertions
        for (int i = 1; i <= 10; i++) {
            tree.insert(i);
        }
        // Demonstrate search
        boolean found = tree.search(5);
        System.out.println("Search for 5: " + found);

        // Demonstrate deletion
        tree.delete(5);
        found = tree.search(5);
        System.out.println("Search for 5 after
deletion: " + found);
    }
}
```

Output:



```

/*Name: Jeel Tikiwala
Student ID: 239659420
Assignment 4
Any and all work in this file is my own.*/
public class TwoThreeTree {
    private Node root;

    public void insert(int key) {
        if (root == null) {
            root = new Node(key);
        } else {
            Node splitNode = insert(root, key);
            if (splitNode != null) {
                Node newRoot = new Node(splitNode.keys[0]);
                newRoot.children[0] = root;
                newRoot.children[1] = splitNode;
                root = newRoot;
            }
        }
    }

    private Node insert(Node node, int key) {
        // Insert logic with node splitting
        // Placeholder for simplicity
        return null;
    }

    public boolean search(int key) {
        Node node = root;
```

```
<terminated> TwoThreeTree [Java Application] /Library/Java/JavaVirtualMachines/temurin-17.jdk/Contents/Home/bin/java  (30-Mar-2024, 2:29:52 pm – 2:29:52 pm) [pid: 22178]
Search for 5: true
Search for 5 after deletion: true
```