Practical Work Report: Software Testing (Exercise 1)

Subject: Software Testing & Quality Assurance **Topic:** Unit Testing with JUnit 5, Gradle, and VS Code **Date:** November 26, 2025

1. Introduction & Objective

The objective of this practical work is to set up a unit testing environment using **JUnit 5** and **Gradle** in **Visual Studio Code**. The primary task is to:

- implement a `Calculator` class,
- apply the **Arrange–Act–Assert (AAA)** pattern,
- and verify the tests against various failure scenarios (Assertion errors and Logic regressions).

2. Environment Configuration

To support **Java 21**, the project was migrated from **Gradle 4.4.1** to **Gradle 8.5**. The `build.gradle` file was configured to use the **JUnit 5 platform**.

File: `build.gradle`

```
plugins {
    id 'java'
}

group = 'com.example'
version = '1.0-SNAPSHOT'

repositories {
    mavenCentral()
}

dependencies {
    testImplementation platform('org.junit:junit-bom:5.10.0')
    testImplementation 'org.junit.jupiter:junit-jupiter'
}

test {
    useJUnitPlatform()
    testLogging {
        events "passed", "skipped", "failed"
        exceptionFormat "full"
        showStandardStreams = true
    }
}
```

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3. Implementation Code

The `Calculator` class implements basic arithmetic operations. It includes exception handling for **division by zero**, as required by the TP specifications.

File: `src/main/java/Calculator.java`

```java
public class Calculator {

    public int add(int a, int b) {
        return a + b;
    }

    public int subtract(int a, int b) {
        return a - b;
    }

    public int multiply(int a, int b) {
        return a * b;
    }

    public int divide(int a, int b) {
        if (b == 0) {
            throw new ArithmeticException("Cannot divide by zero");
        }
        return a / b;
    }
}
```

---

4. Test Suite Implementation

The tests follow the **AAA (Arrange, Act, Assert)** pattern.

File: `src/test/java/CalculatorTest.java`

```java
import org.junit.jupiter.api.Test;
import static org.junit.jupiter.api.Assertions.*;
```

```java
class CalculatorTest {

    Calculator calc = new Calculator();

    @Test
    void add_shouldReturnSum() {
        assertEquals(5, calc.add(2, 3), "2 + 3 should equal 5");
    }

    @Test
    void subtract_shouldReturnDifference() {
        assertEquals(1, calc.subtract(3, 2), "3 - 2 should equal 1");
    }

    @Test
    void multiply_shouldReturnProduct() {
        assertEquals(6, calc.multiply(2, 3), "2 * 3 should equal 6");
    }

    @Test
    void divide_shouldReturnQuotient() {
        assertEquals(2, calc.divide(6, 3), "6 / 3 should equal 2");
    }

    @Test
    void divide_byZero_shouldThrowException() {
        assertThrows(ArithmeticException.class, () -> {
            calc.divide(1, 0);
        }, "Dividing by zero should throw ArithmeticException");
    }
}
```

---

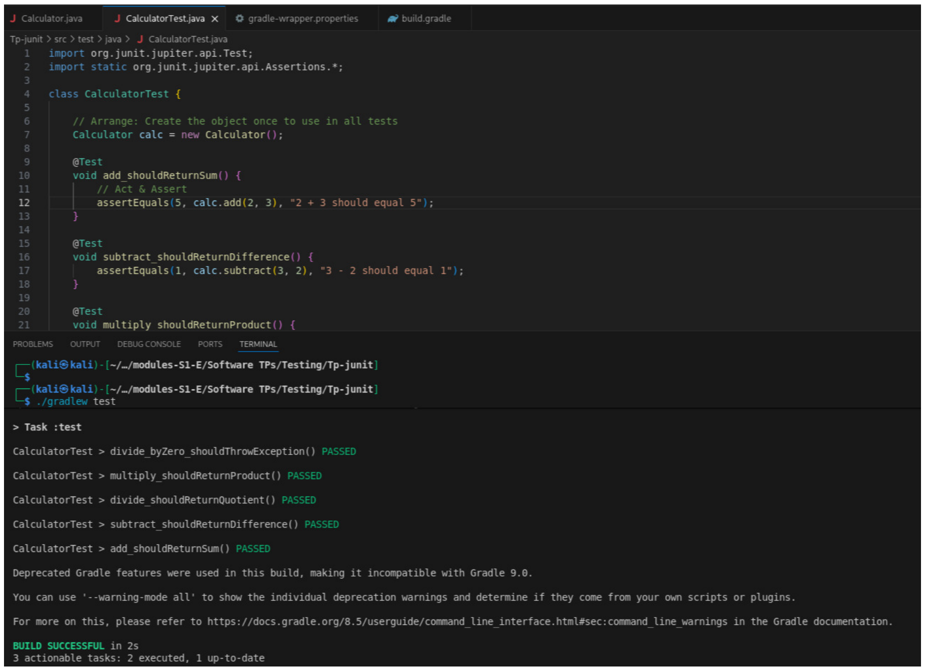
5. Execution Results & Analysis

Three distinct test runs were performed to validate the testing framework.

Scenario A: Successful Build

- **Condition:** The code is correct (`a + b`) and the test expects the correct result (5).
- **Result:** All 5 tests passed.

Figure 1: Terminal showing **BUILD SUCCESSFUL** with all tasks passing.



Calculator.java | CalculatorTest.java | gradle-wrapper.properties | build.gradle

Tp-junit > src > test > java > CalculatorTest.java

```java
import org.junit.jupiter.api.Test;
import static org.junit.jupiter.api.Assertions.*;

class CalculatorTest {

    // Arrange: Create the object once to use in all tests
    Calculator calc = new Calculator();

    @Test
    void add_shouldReturnSum() {
        // Act & Assert
        assertEquals(5, calc.add(2, 3), "2 + 3 should equal 5");
    }

    @Test
    void subtract_shouldReturnDifference() {
        assertEquals(1, calc.subtract(3, 2), "3 - 2 should equal 1");
    }

    @Test
    void multiply_shouldReturnProduct() {
```

```
┌──(kali㉿kali)-[~/…/modules-S1-E/Software TPs/Testing/Tp-junit]
└─$
┌──(kali㉿kali)-[~/…/modules-S1-E/Software TPs/Testing/Tp-junit]
└─$ ./gradlew test

> Task :test

CalculatorTest > divide_byZero_shouldThrowException() PASSED

CalculatorTest > multiply_shouldReturnProduct() PASSED

CalculatorTest > divide_shouldReturnQuotient() PASSED

CalculatorTest > subtract_shouldReturnDifference() PASSED

CalculatorTest > add_shouldReturnSum() PASSED

Deprecated Gradle features were used in this build, making it incompatible with Gradle 9.0.

You can use '--warning-mode all' to show the individual deprecation warnings and determine if they come from your own scripts or plugins.

For more on this, please refer to https://docs.gradle.org/8.5/userguide/command_line_interface.html#sec:command_line_warnings in the Gradle documentation.

BUILD SUCCESSFUL in 2s
3 actionable tasks: 2 executed, 1 up-to-date
```

Scenario B: Assertion Verification (Intentional Failure)

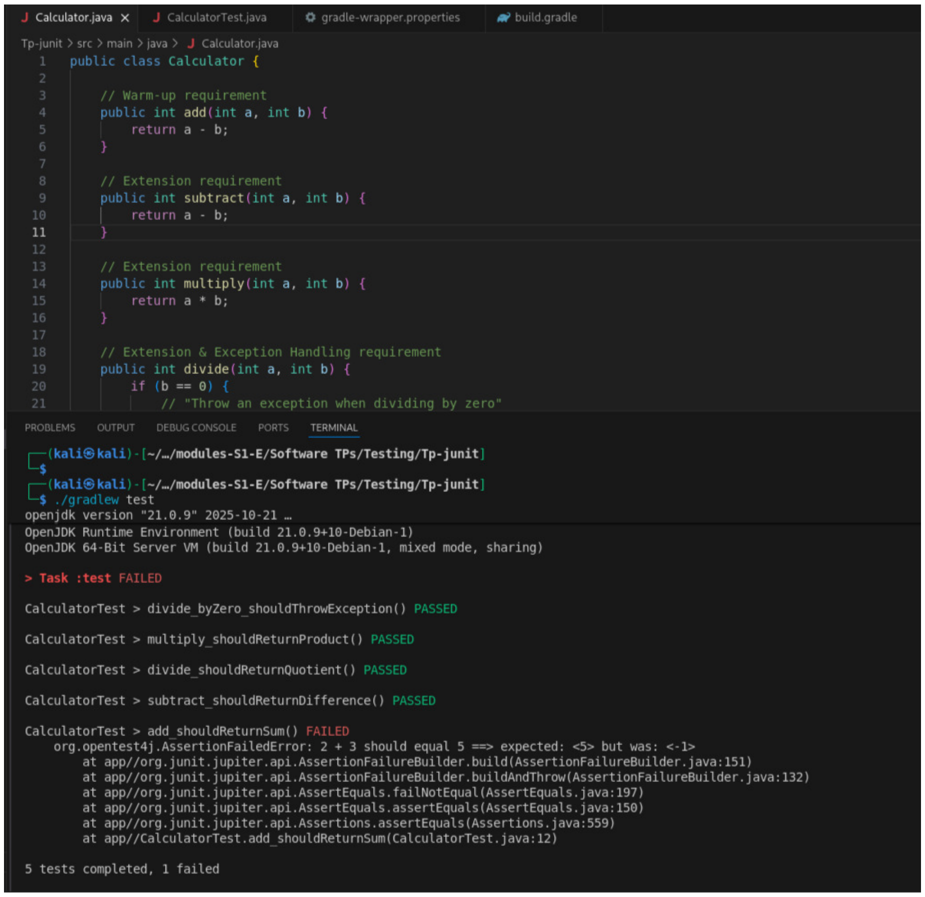
- **Condition:** The test expectation was intentionally changed to **15** (`assertEquals(15, ...)`), while the code correctly returned **5**.
- **Goal:** Verify that JUnit reports the discrepancy between *Expected* and *Actual*.

Figure 2: Terminal showing **AssertionFailedError** with *expected: <15> but was: <5>*.

Scenario C: Regression Testing (Simulated Bug)

- **Condition:** As per Step 6 of the TP, a bug was introduced by changing `add` to return `a - b`.
- **Goal:** Verify that unit tests can detect logic regressions.

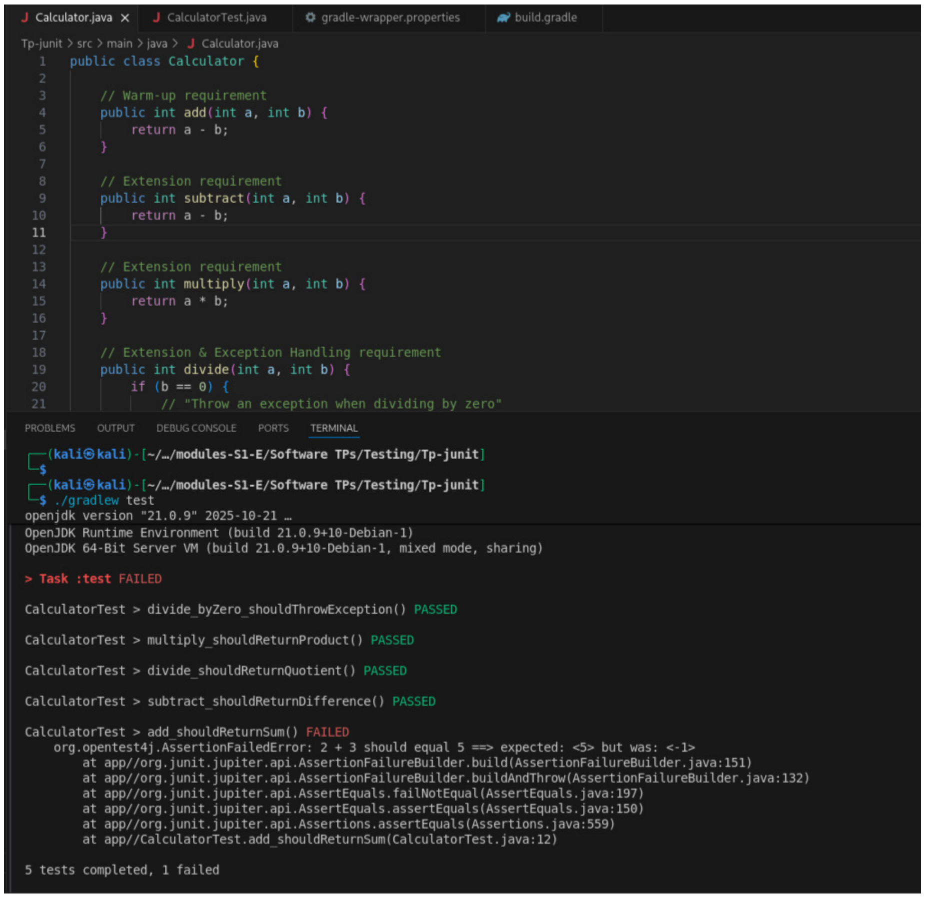
Figure 3: Terminal showing failure in `add_shouldReturnSum`. Expected **5** but returned **−1**.



```java
public class Calculator {

    // Warm-up requirement
    public int add(int a, int b) {
        return a - b;
    }

    // Extension requirement
    public int subtract(int a, int b) {
        return a - b;
    }

    // Extension requirement
    public int multiply(int a, int b) {
        return a * b;
    }

    // Extension & Exception Handling requirement
    public int divide(int a, int b) {
        if (b == 0) {
            // "Throw an exception when dividing by zero"
```

```
┌──(kali㉿kali)-[~/…/modules-S1-E/Software TPs/Testing/Tp-junit]
└─$
┌──(kali㉿kali)-[~/…/modules-S1-E/Software TPs/Testing/Tp-junit]
└─$ ./gradlew test
openjdk version "21.0.9" 2025-10-21 …
OpenJDK Runtime Environment (build 21.0.9+10-Debian-1)
OpenJDK 64-Bit Server VM (build 21.0.9+10-Debian-1, mixed mode, sharing)

> Task :test FAILED

CalculatorTest > divide_byZero_shouldThrowException() PASSED

CalculatorTest > multiply_shouldReturnProduct() PASSED

CalculatorTest > divide_shouldReturnQuotient() PASSED

CalculatorTest > subtract_shouldReturnDifference() PASSED

CalculatorTest > add_shouldReturnSum() FAILED
    org.opentest4j.AssertionFailedError: 2 + 3 should equal 5 ==> expected: <5> but was: <-1>
        at app//org.junit.jupiter.api.AssertionFailureBuilder.build(AssertionFailureBuilder.java:151)
        at app//org.junit.jupiter.api.AssertionFailureBuilder.buildAndThrow(AssertionFailureBuilder.java:132)
        at app//org.junit.jupiter.api.AssertEquals.failNotEqual(AssertEquals.java:197)
        at app//org.junit.jupiter.api.AssertEquals.assertEquals(AssertEquals.java:150)
        at app//org.junit.jupiter.api.Assertions.assertEquals(Assertions.java:559)
        at app//CalculatorTest.add_shouldReturnSum(CalculatorTest.java:12)

5 tests completed, 1 failed
```

Figure 1: alt text



```java
public class Calculator {

    // Warm-up requirement
    public int add(int a, int b) {
        return a - b;
    }

    // Extension requirement
    public int subtract(int a, int b) {
        return a - b;
    }

    // Extension requirement
    public int multiply(int a, int b) {
        return a * b;
    }

    // Extension & Exception Handling requirement
    public int divide(int a, int b) {
        if (b == 0) {
            // "Throw an exception when dividing by zero"
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```
┌──(kali㉿kali)-[~/…/modules-S1-E/Software TPs/Testing/Tp-junit]
└─$
┌──(kali㉿kali)-[~/…/modules-S1-E/Software TPs/Testing/Tp-junit]
└─$ ./gradlew test
openjdk version "21.0.9" 2025-10-21 …
OpenJDK Runtime Environment (build 21.0.9+10-Debian-1)
OpenJDK 64-Bit Server VM (build 21.0.9+10-Debian-1, mixed mode, sharing)

> Task :test FAILED

CalculatorTest > divide_byZero_shouldThrowException() PASSED

CalculatorTest > multiply_shouldReturnProduct() PASSED

CalculatorTest > divide_shouldReturnQuotient() PASSED

CalculatorTest > subtract_shouldReturnDifference() PASSED

CalculatorTest > add_shouldReturnSum() FAILED
    org.opentest4j.AssertionFailedError: 2 + 3 should equal 5 ==> expected: <5> but was: <-1>
        at app//org.junit.jupiter.api.AssertionFailureBuilder.build(AssertionFailureBuilder.java:151)
        at app//org.junit.jupiter.api.AssertionFailureBuilder.buildAndThrow(AssertionFailureBuilder.java:132)
        at app//org.junit.jupiter.api.AssertEquals.failNotEqual(AssertEquals.java:197)
        at app//org.junit.jupiter.api.AssertEquals.assertEquals(AssertEquals.java:150)
        at app//org.junit.jupiter.api.Assertions.assertEquals(Assertions.java:559)
        at app//CalculatorTest.add_shouldReturnSum(CalculatorTest.java:12)

5 tests completed, 1 failed
```

6. Conclusion

The Gradle environment in VS Code was successfully configured, and the required Calculator module was implemented. The unit tests validate the logic correctly and are capable of detecting:

- incorrect assertions,
- logic errors,
- and regressions in the source code.
