Advanced Programming

Software Testing — Foundations, Tools, Practices

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What is Software Testing?

- Software Testing is the process of **verifying and validating** that a software system:
    - Works correctly
    - Meets requirements
    - Handles errors gracefully
    - Maintains quality over time

> Testing is not optional — it is essential for reliability & maintainability.

QA vs Testing

Aspect	QA (Quality Assurance)	Testing
Focus	Process & standards	Software behavior
Goal	Prevent defects	Find defects
Activities	Reviews, guidelines, documentation	Executing test cases
Responsibility	Whole team	Testers + Developers

> QA = Prevention
>
> Testing = Detection

Unit Testing

- Tests **smallest functional units** (methods/classes)
- Must be:
  - **Fast**
  - **Repeatable**
  - **Independent**
- Written and maintained by **developers**

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

Unit test verifies:

```
assertEquals(5, add(2, 3));
```

> Unit Tests prove code correctness in isolation.

JUnit — Standard Java Testing Framework

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

class CalculatorTest {

    @Test
    void testAdd() {
        Calculator c = new Calculator();
        assertEquals(7, c.add(3, 4));
    }
}
```

- **@Test** marks a test method
- **assertEquals** checks expected vs actual values

> JUnit is the core testing tool in Java environments.

Throwing and Testing Exceptions

```java
class BankAccount {
    private double balance = 0;
    public void withdraw(double amount) {
        if (amount > balance)
            throw new IllegalArgumentException("Insufficient funds");
        balance -= amount;
    }
}
```

Testing the thrown exception:

```java
@Test
void testWithdrawException() {
    BankAccount b = new BankAccount();
    assertThrows(IllegalArgumentException.class, () -> b.withdraw(100));
}
```

> Exception testing ensures **safe failure behavior**.

Mocking — What and Why?

Mocking is the practice of replacing real dependencies with **fake (mock) objects** during testing.

We use mocks when the class under test depends on something external, such as:

- Database
- File System
- Network service
- External API

Mocks allow us to test **logic in isolation** — without relying on the real world.

> When your tests depend on the outside world, they become slow, flaky, and unreliable.

Benefits of Mocking

Without Mocking	With Mocking
Tests are slow	Tests are fast
Results vary due to environment	Results are consistent
Requires real external setup	No external setup needed
Failures are hard to debug	Failures are predictable and isolated

> Mocking helps ensure your tests are **stable, deterministic, and fast**.

Example Using Mockito

```java
import static org.mockito.Mockito.*;
import org.junit.jupiter.api.Test;
class NotificationServiceTest {

    @Test
    void testSendMessage() {
        MessageGateway gateway = mock(MessageGateway.class);
        NotificationService service = new NotificationService(gateway);

        service.send("Hi");
        verify(gateway).deliver("Hi");
    }
}
```

- `mock()` creates a fake dependency
- `verify()` checks that a method was called

Concept Diagram

```
Real Email Service  ❌ (slow, network required)
         ↓
  Mock Email Service  ✅ (fast, controlled behavior)
```

> We are testing **NotificationService**, not the actual email delivery process.

Developer Humor (Because Testing Needs It)

- “My code works.”
  “Did you test it?”
  “Well… it *worked on my machine*.”
- Writing tests without mocking:
  “Why is the test connecting to the production database?”
- QA: “I don't trust your code.”
  Developer: “Fair. I don't trust it either.”
- The biggest lie in software development:
  “We will write the tests later.”

Mocking Dependencies

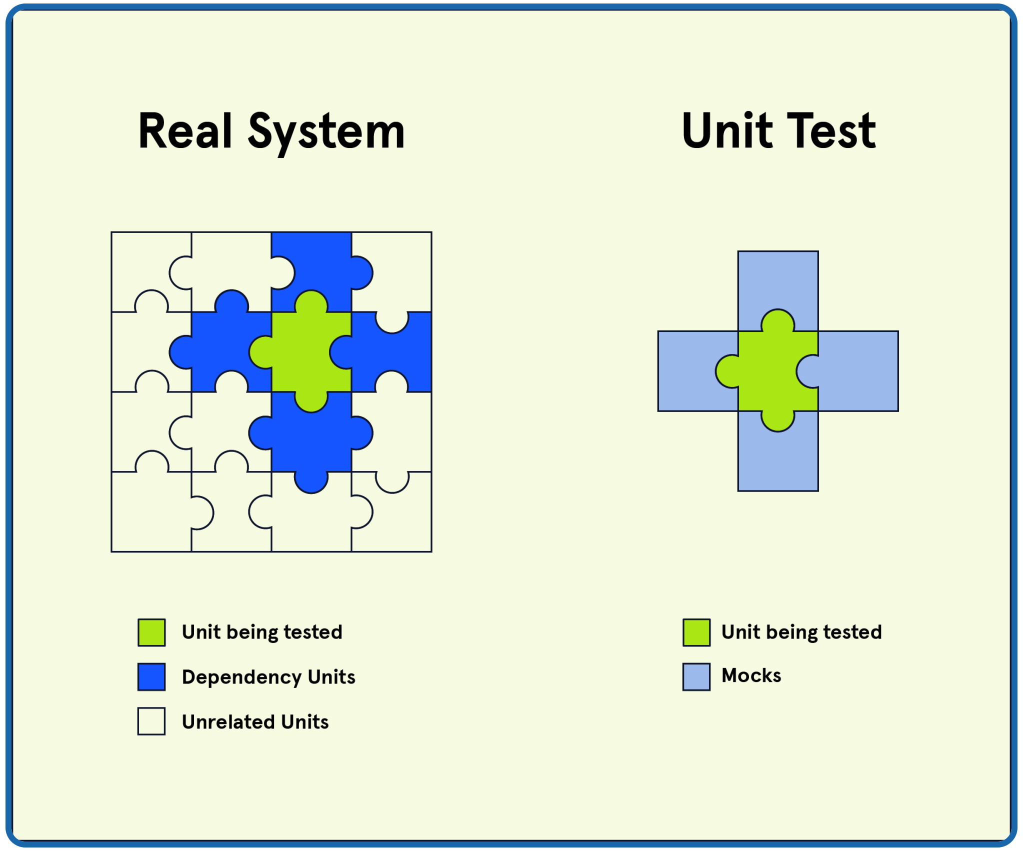
Used when:

- The class you're testing depends on something **external**:
    - Database
    - Network
    - File system
    - API service

We **replace real dependencies** with **mocks**.

```java
@Mock EmailService email;
@InjectMocks UserManager manager;
```

Mocking isolates **logic** from external systems → reliable tests.



Real world systems rely heavily on mocking frameworks like Mockito.

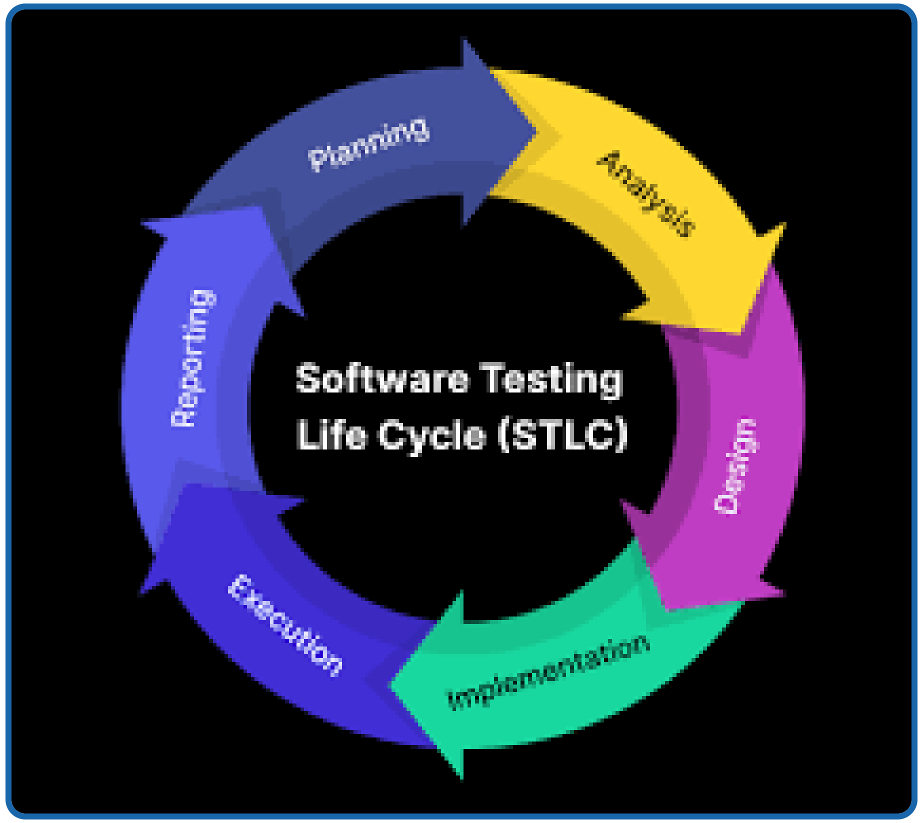
Summary

Concept	Description
QA	Process of maintaining quality
Unit Test	Tests the smallest components
JUnit	The standard Java test framework
Exceptions	Must be tested, not ignored
Mocking	Isolates code from dependencies

> Consistent testing → Software that is stable, trustworthy, and maintainable.

Thank You!

Software Testing — Core Foundations


Software Testing Life Cycle (STLC)
Planning
Analysis
Design
Implementation
Execution
Reporting