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Backend Development

Chapter 6: Testing

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TABLE CONTENT

LESSON OBJECTIVES

- Understanding the Difference Between Unit Test & Integration Test
- Know how to write tests in ASP.NET Core with xUnit, Moq, TestServer
- Apply tests to Controllers, Services, and Repositories

WHY WE NEED TESTING?

- Make sure the logic is correct when the code is complex
- Refactor, CI/CD
- Early Fault Detection → Cost Savings

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UNIT TEST

What is Unit Test?

- Test the smallest unit of the application (function, method, class)
- No Database, API, or Network Involvement

Example:

```
decimal CalculateDiscount(Order order)
```

- → Test the exact value returned for each input

Unit Test Tool for ASP.NET Core

- xUnit: Official Test Framework
- MOQ: Create a mock object to isolate the unit test
- FluentAssertions: Writing asserts is easier to understand

AAA (Arrange–Act–Assert) Model

- Arrange – Prepare data/mock
- Act – Calling the function to be tested
- Assert – Check the return results

```
// Arrange
var service = new OrderService();
var order = new Order(...);

// Act
var total = service.CalculateTotal(order);

// Assert
Assert.Equal(500, total);
```

Demo Unit Test with xUnit + MOQ

```
[Fact]
public void GetProductPrice_WithDiscount_ReturnsCorrectPrice()
{
    var mockRepo = new Mock<IProductRepository>();
    mockRepo.Setup(r => r.GetBasePrice(1)).Returns(100);

    var service = new ProductService(mockRepo.Object);

    var price = service.GetFinalPrice(1);

    Assert.Equal(90, price);
}
```

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When should we write a Unit Test?

- ✅ Write when processing computational logic, validate
- ✅ When fixing bugs: write tests to control bugs
- ✅ Before refactor code
- ❌ Don't write Unit Tests for UI or call real DBs

Common mistakes

- ❌ No separation of logic from dependencies (non-DI)
- ❌ Write a real DB dependency test (→ Integration Test)
- ❌ Not asserting enough cases (e.g., null, exception)
- ❌ The test is too general → it is not clear where the error is

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Advantages of Unit Test

- ⚡ Very fast → CI/CD compliant
- 🔁 Easy retesting when changing
- 🎯 Focus on the right core logic
- ✅ Easy to write, easy to maintain

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INTEGRATION TESTS

What is Integration Test?

Test the coordination between layers in the application

Comprise: Controller → Service → DB (In-Memory or real) Are endpoint checks working as expected?

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Integration Test Tool in ASP.NET Core

- Microsoft.AspNetCore.Mvc.Testing
- WebApplicationFactory<TStartup> – Create a real app to test
- HttpClient – Submit a mock request
- SQLite InMemory, Testcontainers – Lightweight DB test

Integration Test API Example

```
[Fact]
public async Task PostOrder_Returns201Created()
{
    var client = _factory.CreateClient();
    var response = await client.PostAsJsonAsync("/api/orders", new OrderDto(...));

    Assert.Equal(HttpStatusCode.Created, response.StatusCode);
}
```

- Check the API /api/orders works correctly
- Test data stored in DB In-Memory

Advantages of Integration Test

- Close to the actual operation of the system
- Coordinated logic error detection
- Can be falsely detected when mapping model → entity → DB

Disadvantages of Integration Test

- Longer runtime than Unit Test
- More complicated setup
- If you don't isolate your tests → data conflicts

Advantages of Integration Test

- Close to the actual operation of the system
- Coordinated logic error detection
- Can be falsely detected when mapping model → entity → DB

How to combine the two types of tests?

Type of Test	Percent
Unit Test	70%
Integration Test	30%

Visual Comparison

Criteria	Unit Test	Integration Test
Scope	Function, small class	Full API Flow
Database Dependencies	Not	Yes/InMemory
Speed	Very fast	Average
Complexity	Easy	Harder

Conclusion

- Unit Test: test logic Core – Fast, Separate
- Integration Test: Endpoint coordination test – close to reality
- Combine the two for optimal quality for ASP.NET Core applications

Install xUnit, MOQ, and FluentAssertions

- dotnet add package xunit
- dotnet add package Moq
- dotnet add package FluentAssertions
- dotnet add package Microsoft.NET.Test.Sdk
- dotnet add package xunit.runner.visualstudio
- dotnet add package coverlet.collector

You can check the installed packages in MyApp.Tests.csproj.

(Optional) Install test integration with WebApplicationFactory

- dotnet add package Microsoft.AspNetCore.Mvc.Testing

Used for Integration Test (emulating API requests via TestServer).

Configure MyApp.Tests.csproj (if needed)

```
<PropertyGroup>
  <TargetFramework>net8.0</TargetFramework>
  <IsPackable>false</IsPackable>
</PropertyGroup>

<ItemGroup>
  <PackageReference Include="Moq" Version="4.18.4" />
  <PackageReference Include="xunit" Version="2.4.2" />
  <PackageReference Include="xunit.runner.visualstudio" Version="2.4.5" />
  <PackageReference Include="FluentAssertions" Version="6.11.0" />
  <PackageReference Include="coverlet.collector" Version="3.2.0" />
  <PackageReference Include="Microsoft.AspNetCore.Mvc.Testing"
Version="7.0.10" />
</ItemGroup>
```

Test run

Create file SampleTest.cs in MyApp.Tests:

```
using Xunit;

namespace MyApp.Tests;

public class SampleTest
{
    [Fact]
    public void SimpleAddition_WorksCorrectly()
    {
        int result = 2 + 3;
        Assert.Equal(5, result);
    }
}
```

Run the test:

```
dotnet test
```

Configure test coverage (optional)

Thêm vào file MyApp.Tests.csproj:

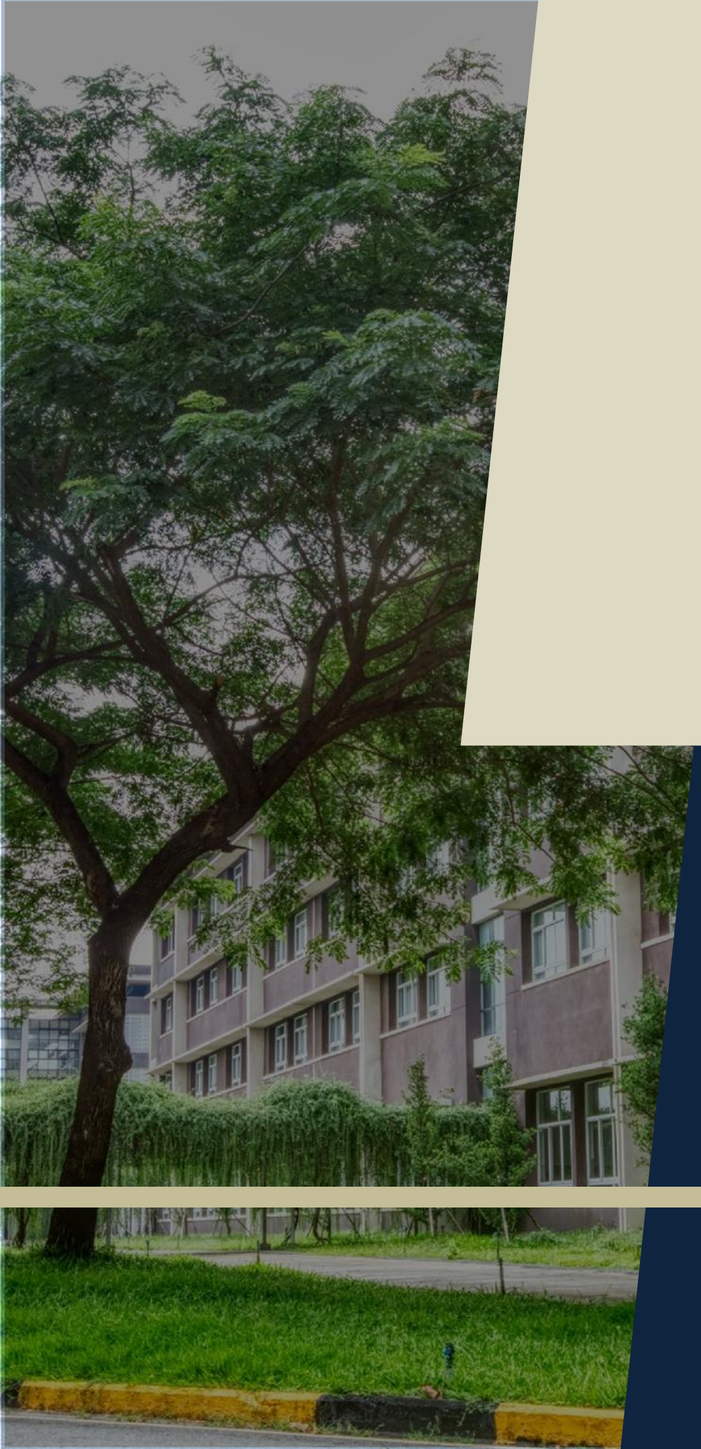
```
<CollectCoverage>true</CollectCoverage>
<CoverletOutputFormat>opencover</CoverletOutputFormat>
```

Professional Test Directory Organization

```
MyApp.Tests/
├── Services/
│   └── OrderServiceTests.cs
├── Controllers/
│   └── OrdersControllerTests.cs
├── Integration/
│   └── OrdersApiTests.cs
```

Summary of main packages

Package	Purpose
xUnit	Framework Main Testing
Moq	Interface and dependency forgery
FluentAssertions	Write asserts more clearly
Microsoft.AspNetCore.Mvc.Testing	Test Integration API
coverlet.collector	Calculate coverage when running tests



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