CEN206 Object-Oriented Programming

Final Project Progress Review & Course Summary

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CEN206 Object-Oriented Programming

Week-15 (Final Project Progress Review & Course Summary)

Spring Semester, 2025-2026 Download DOC-PDF[1], DOC-DOCX[2], SLIDE[3]

Week-15 Overview

Final Project Progress Review & Course Summary

Module	Topic
A	Course Review – OOP Fundamentals (Weeks 1-7)
B	Course Review – Design Patterns & Refactoring (Weeks 9-14)
C	Final Project Requirements & Evaluation
D	Project Demonstration Guidelines
E	Final Exam Preparation

Purpose of This Week

- Consolidate **all knowledge** gained throughout the semester
- Clarify **final project** expectations and evaluation criteria
- Provide **demonstration guidelines** for project presentations
- Prepare students for the **final exam**
- Answer remaining questions and address concerns

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Module A: Course Review – OOP Fundamentals

Weeks 1-7 Recap

Module A Outline

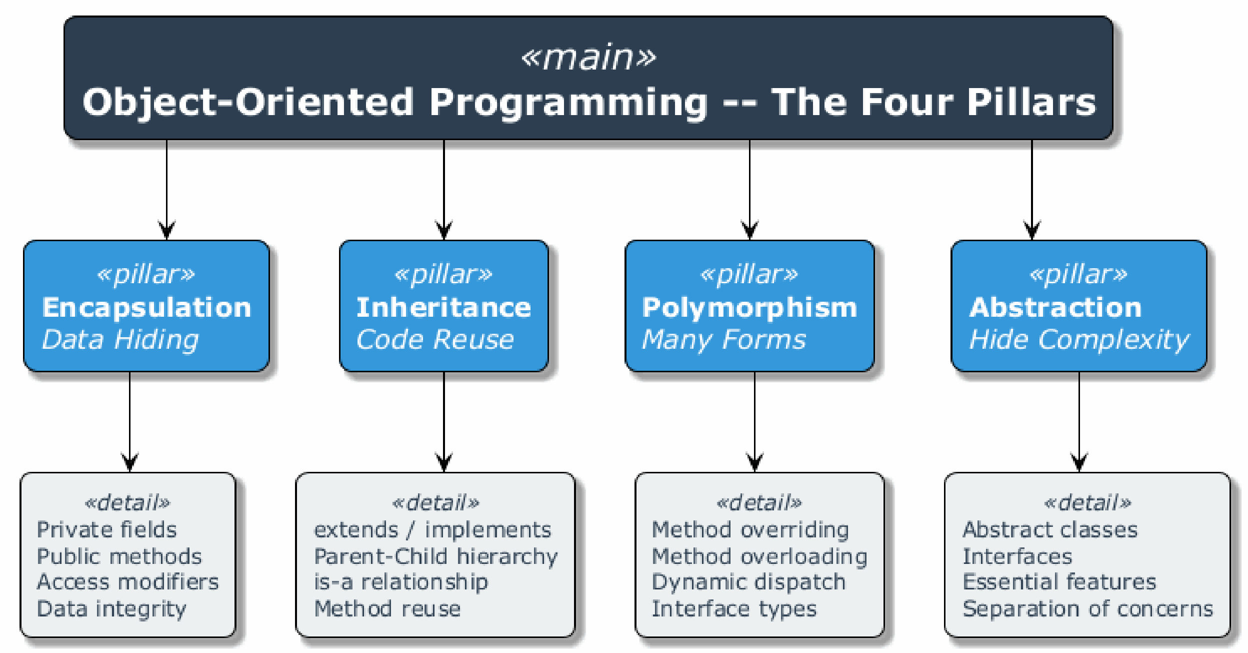
Course Review – OOP Fundamentals (Weeks 1-7)

1. Weeks 1-3: Core OOP Concepts
2. Week 4: UML Diagrams
3. Week 5: PlantUML
4. Weeks 6-7: UMPLE
5. Key Takeaways from Each Topic

Weeks 1-3: Core OOP Concepts

The Four Pillars of Object-Oriented Programming

Pillar	Description	Key Mechanism
Encapsulation	Bundling data and methods together, hiding internal state	Access modifiers (`private`, `protected`, `public`)
Inheritance	Creating new classes from existing ones, reusing code	`extends` (Java), `:` (C++)
Polymorphism	Same interface, different implementations	Method overriding, method overloading
Abstraction	Exposing only essential features, hiding complexity	Abstract classes, interfaces



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Weeks 1-3: Encapsulation Review

- **What:** Restricting direct access to an object's internal state and requiring interaction through well-defined methods.
- **Why:** Protects data integrity, reduces coupling, enables implementation changes without affecting clients.

```java
public class BankAccount {
    private double balance; // hidden internal state

    public double getBalance() {
        return balance;
    }

    public void deposit(double amount) {
        if (amount > 0) {
            balance += amount;
        }
    }

    public boolean withdraw(double amount) {
        if (amount > 0 && amount <= balance) {
            balance -= amount;
            return true;
        }
        return false;
    }
}
```

Weeks 1-3: Inheritance Review

- **What:** A mechanism where a child class inherits fields and methods from a parent class.
- **Why:** Code reuse, establishing is-a relationships, building class hierarchies.

```java
public class Animal {
    protected String name;

    public void eat() {
        System.out.println(name + " is eating.");
    }
}

public class Dog extends Animal {
    public Dog(String name) {
        this.name = name;
    }

    public void bark() {
        System.out.println(name + " is barking.");
    }
}
```

Weeks 1-3: Polymorphism Review

- **What:** The ability of objects of different classes to respond to the same method call in different ways.
- **Why:** Enables flexible, extensible code that works with abstractions rather than concrete types.

```java
public abstract class Shape {
    public abstract double area();
}

public class Circle extends Shape {
    private double radius;
    public Circle(double r) { this.radius = r; }
    public double area() { return Math.PI * radius * radius; }
}

public class Rectangle extends Shape {
    private double width, height;
    public Rectangle(double w, double h) { this.width = w; this.height = h; }
    public double area() { return width * height; }
}

// Polymorphic usage
Shape s = new Circle(5);
System.out.println(s.area()); // calls Circle's area()
```

Weeks 1-3: Abstraction Review

- **What:** Defining essential characteristics of an object while hiding the implementation details.
- **Why:** Simplifies complex systems, focuses on what an object does rather than how it does it.

```java
public interface Sortable {
    void sort(int[] data);
}

public class QuickSort implements Sortable {
    public void sort(int[] data) {
        // Quick sort implementation hidden from clients
        quickSort(data, 0, data.length - 1);
    }
    private void quickSort(int[] arr, int low, int high) { /* ... */ }
}

public class MergeSort implements Sortable {
    public void sort(int[] data) {
        // Merge sort implementation hidden from clients
        mergeSort(data, 0, data.length - 1);
    }
    private void mergeSort(int[] arr, int low, int high) { /* ... */ }
}
```

Week 4: UML Diagrams Review

Unified Modeling Language

Diagram Type	Category	Purpose
Class Diagram	Structural	Shows classes, attributes, methods, and relationships
Object Diagram	Structural	Shows instances at a specific point in time

Diagram Type	Category	Purpose
Sequence Diagram	Behavioral	Shows object interactions over time
Use Case Diagram	Behavioral	Shows system functionality from user perspective
Activity Diagram	Behavioral	Shows workflow and business processes
State Machine Diagram	Behavioral	Shows object state transitions
Component Diagram	Structural	Shows system components and dependencies

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Week 4: Class Diagram Relationships Review

Relationship	Symbol	Meaning	Example
Association	solid line	“uses” or “knows about”	Student – Course
Aggregation	open diamond	“has-a” (weak ownership)	Department <>– Professor
Composition	filled diamond	“owns” (strong ownership)	House <>– Room
Inheritance	open triangle arrow	“is-a”	Dog –> Animal
Realization	dashed triangle arrow	“implements”	ArrayList ..> List
Dependency	dashed arrow	“depends on”	Client ..> Service

Week 5: PlantUML Review

Key Features

- **Text-based** UML diagramming tool
- Converts plain text descriptions into UML diagrams
- Supports class diagrams, sequence diagrams, use case diagrams, and more
- Integrates with IDEs, CI/CD pipelines, and documentation tools

```
@startuml
class Animal {
  - name: String
  + eat(): void
}

class Dog extends Animal {
  + bark(): void
}

class Cat extends Animal {
  + meow(): void
}
@enduml
```

Weeks 6-7: UMPLE Review

Key Features

- **Model-Oriented Programming** language
- Adds modeling constructs directly into programming languages (Java, C++, PHP)
- Supports associations, state machines, and design patterns
- Generates executable code from models

```
class Student {
  name;
  Integer studentId;
  1 -- * Course;
}

class Course {
  title;
  Integer courseCode;
}
```

Weeks 6-7: UMPLE Associations & State Machines

Associations

Multiplicity	Meaning	Example
`1 -- *`	One-to-many	One Student has many Courses
`* -- *`	Many-to-many	Students and Clubs
`0..1 -- *`	Optional one-to-many	Mentor and Students

State Machines

```
class TrafficLight {
  status {
    Red { timer -> Green; }
    Green { timer -> Yellow; }
    Yellow { timer -> Red; }
  }
}
```

Module A – Takeaway

OOP Fundamentals: Key Points

Week	Topic	Core Skill Gained
1-3	OOP Concepts	Understanding encapsulation, inheritance, polymorphism, abstraction
4	UML Diagrams	Modeling software systems visually
5	PlantUML	Automating UML diagram generation from text
6-7	UMPLE	Model-oriented programming and code generation

Remember: OOP is not just about syntax – it is about **thinking in objects**, designing **clean abstractions**, and building **maintainable systems**.

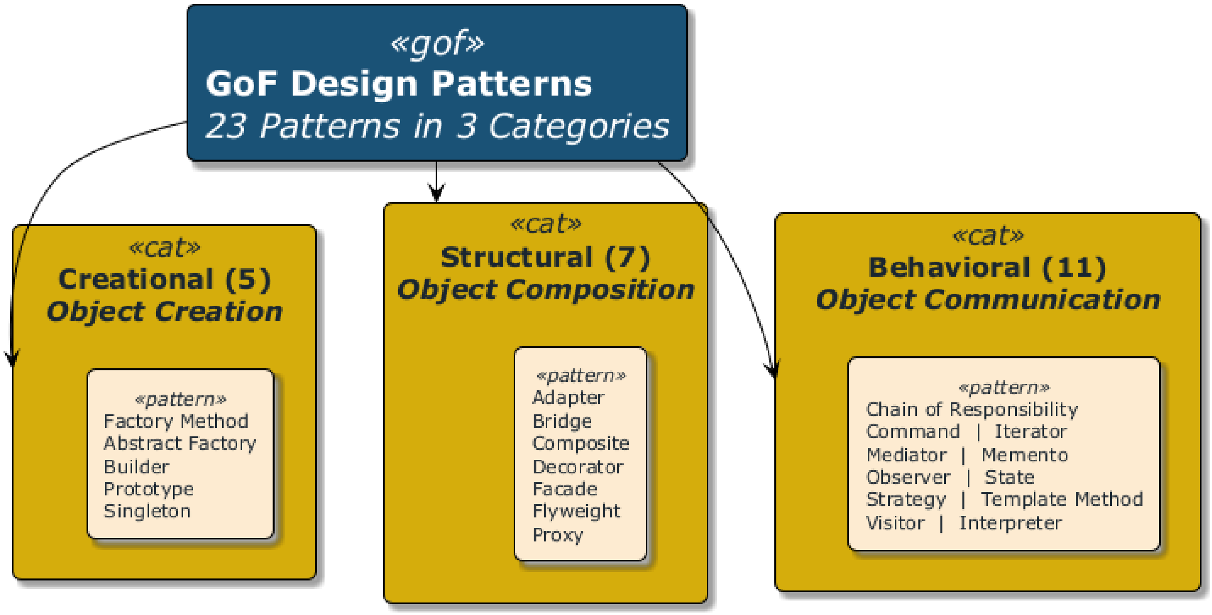
Module B: Course Review – Design Patterns & Refactoring

Weeks 9-14 Recap

Module B Outline

Design Patterns & Refactoring (Weeks 9-14)

1. Week 9: Creational Patterns (5 patterns)
2. Week 10: Structural Patterns (7 patterns)
3. Week 11: Behavioral Patterns (10 patterns)
4. Week 12: Code Smells (5 categories, 22 smells)
5. Week 13: Refactoring Techniques (6 categories, 66 techniques)
6. Week 14: Case Studies and Best Practices
7. Pattern Selection Decision Guide



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Week 9: Creational Design Patterns Summary

5 Patterns for Object Creation

#	Pattern	Intent	When to Use
1	**Factory Method**	Define an interface for creating objects, letting subclasses decide the type	When a class cannot anticipate the type of objects it needs to create
2	**Abstract Factory**	Create families of related objects without specifying concrete classes	When the system must be independent of how its products are created

#	Pattern	Intent	When to Use
3	**Builder**	Separate the construction of a complex object from its representation	When creating objects with many optional parameters
4	**Prototype**	Create new objects by copying existing ones	When object creation is expensive and similar objects already exist
5	**Singleton**	Ensure a class has only one instance and provide global access	When exactly one instance is needed (e.g., configuration, logging)

Week 10: Structural Design Patterns Summary

7 Patterns for Class/Object Composition

#	Pattern	Intent	When to Use
1	**Adapter**	Convert one interface to another that clients expect	When you need to use an existing class with an incompatible interface
2	**Bridge**	Separate abstraction from implementation	When both abstraction and implementation may vary independently
3	**Composite**	Compose objects into tree structures for part-whole hierarchies	When you need to treat individual objects and compositions uniformly
4	**Decorator**	Attach additional responsibilities dynamically	When you need to add behavior without subclassing
5	**Facade**	Provide a simplified interface to a complex subsystem	When you need a simple interface to a complex system
6	**Flyweight**	Share objects to support large numbers efficiently	When many similar objects consume excessive memory
7	**Proxy**	Provide a surrogate or placeholder for another object	When you need controlled access, lazy loading, or logging

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Week 11: Behavioral Design Patterns Summary

10 Patterns for Object Communication

#	Pattern	Intent	When to Use
1	**Chain of Responsibility**	Pass request along a chain of handlers	When multiple objects may handle a request
2	**Command**	Encapsulate a request as an object	When you need undo/redo, queuing, or logging of requests
3	**Iterator**	Access elements sequentially without exposing internals	When you need uniform traversal of collections

#	Pattern	Intent	When to Use
4	**Mediator**	Define centralized communication between objects	When many objects communicate in complex ways
5	**Memento**	Capture and restore object state	When you need undo/rollback functionality
6	**Observer**	Notify dependents automatically when state changes	When one object change should update many others
7	**State**	Alter behavior when internal state changes	When behavior depends on state and changes at runtime
8	**Strategy**	Define interchangeable algorithms	When you need to select an algorithm at runtime
9	**Template Method**	Define algorithm skeleton, letting subclasses fill in steps	When subclasses should customize parts of an algorithm
10	**Visitor**	Add operations to objects without modifying them	When you need to perform operations across a class hierarchy

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Week 12: Code Smells Summary

5 Categories, 22 Smells

Category	Smells	Key Indicator
Bloaters	Long Method, Large Class, Primitive Obsession, Long Parameter List, Data Clumps	Code that grows excessively large
Object-Orientation Abusers	Switch Statements, Temporary Field, Refused Bequest, Alternative Classes with Different Interfaces	Improper use of OOP principles
Change Preventers	Divergent Change, Shotgun Surgery, Parallel Inheritance Hierarchies	Changes require modifications in many places
Dispensables	Comments (excessive), Duplicate Code, Lazy Class, Data Class, Dead Code, Speculative Generality	Unnecessary code that adds complexity
Couplers	Feature Envy, Inappropriate Intimacy, Message Chains, Middle Man, Incomplete Library Class	Excessive coupling between classes

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Week 13: Refactoring Techniques Summary

6 Categories, 66 Techniques

Category	Count	Purpose	Key Techniques
Composing Methods	9	Better method structure	Extract Method, Inline Method, Extract Variable
Moving Features	8	Proper feature placement	Move Method, Move Field, Extract Class
Organizing Data	15	Better data management	Encapsulate Field, Replace Magic Number, Replace Type Code
Simplifying Conditionals	8	Cleaner conditional logic	Decompose Conditional, Replace Conditional with Polymorphism
Simplifying Method Calls	14	Better method interfaces	Rename Method, Add/Remove Parameter, Parameterize Method
Dealing with Generalization	12	Better inheritance hierarchies	Pull Up Method, Push Down Method, Extract Interface

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Week 14: Case Studies & Best Practices

Key Lessons

- **Real-world applications** of design patterns in industry projects
- **Pattern combinations** – how patterns work together in practice
- **Anti-patterns** – common mistakes and how to avoid them
- **SOLID principles** applied alongside design patterns
  - **S** – Single Responsibility Principle
  - **O** – Open/Closed Principle
  - **L** – Liskov Substitution Principle
  - **I** – Interface Segregation Principle
  - **D** – Dependency Inversion Principle

Pattern Selection Decision Guide

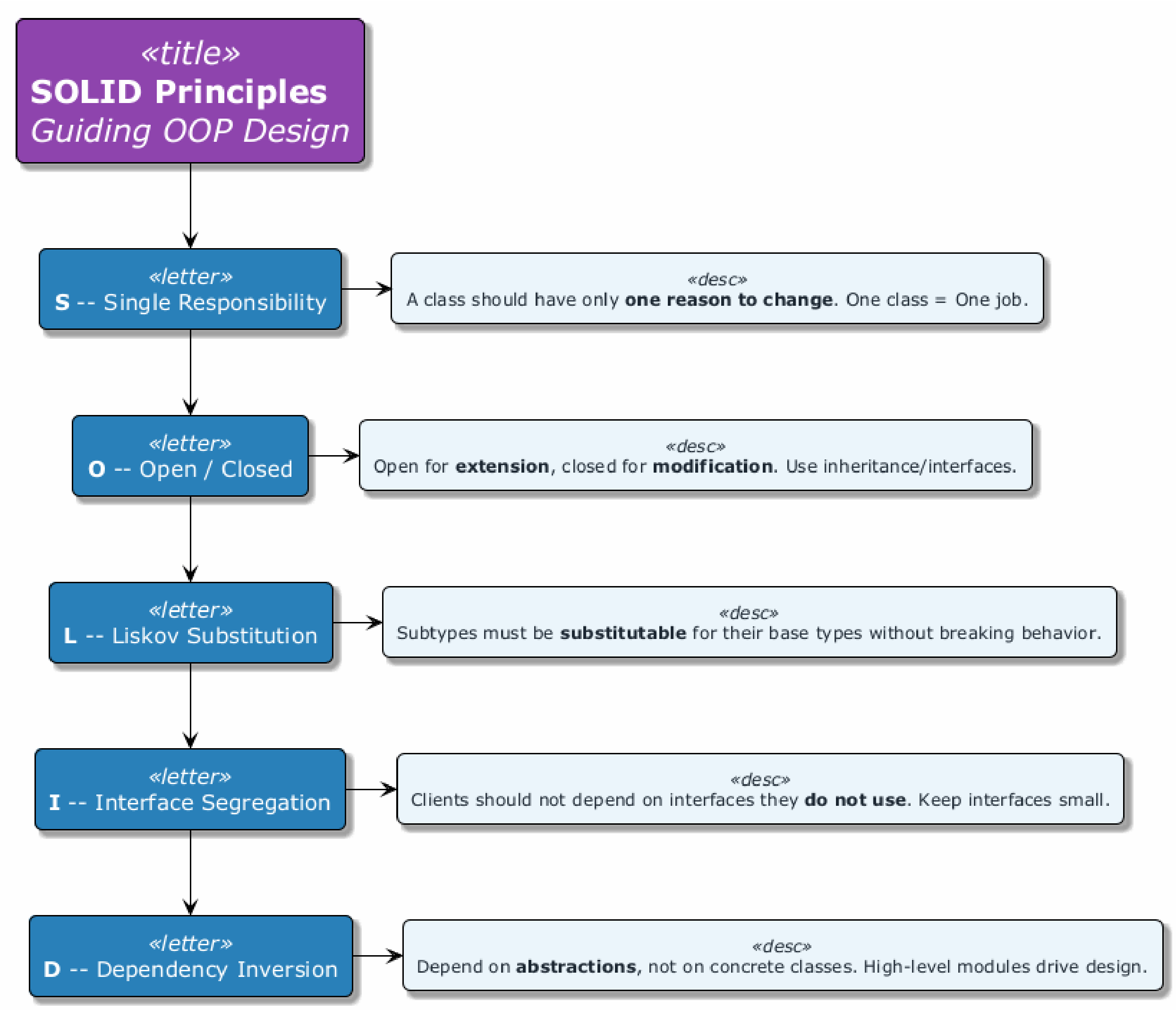
How to Choose the Right Pattern

```
Is your problem about...

CREATING objects?
  |-- Need one instance only?           --> Singleton
  |-- Need families of related objects? --> Abstract Factory
  |-- Need flexible object construction?--> Builder
  |-- Need to copy existing objects?    --> Prototype
  |-- Need subclass to decide type?     --> Factory Method

STRUCTURING classes?
  |-- Need to adapt an interface?       --> Adapter
  |-- Need to add behavior dynamically? --> Decorator
  |-- Need a simplified interface?      --> Facade
  |-- Need tree structures?             --> Composite
  |-- Need controlled access?           --> Proxy

MANAGING behavior?
  |-- Need to notify on state change?   --> Observer
```



«title»
SOLID Principles
Guiding OOP Design

«letter»
S -- Single Responsibility

«desc»
A class should have only **one reason to change**. One class = One job.

«letter»
O -- Open / Closed

«desc»
Open for **extension**, closed for **modification**. Use inheritance/interfaces.

«letter»
L -- Liskov Substitution

«desc»
Subtypes must be **substitutable** for their base types without breaking behavior.

«letter»
I -- Interface Segregation

«desc»
Clients should not depend on interfaces they **do not use**. Keep interfaces small.

«letter»
D -- Dependency Inversion

«desc»
Depend on **abstractions**, not on concrete classes. High-level modules drive design.

Figure 3: center

```
  |-- Need interchangeable algorithms?  --> Strategy
  |-- Need to encapsulate requests?     --> Command
  |-- Need to traverse a collection?    --> Iterator
  |-- Need state-dependent behavior?    --> State
```

Module B – Takeaway

Design Patterns & Refactoring: Key Points

Week	Topic	Core Skill Gained
9	Creational Patterns	Flexible and decoupled object creation
10	Structural Patterns	Composing classes and objects effectively
11	Behavioral Patterns	Managing complex object interactions
12	Code Smells	Identifying problematic code
13	Refactoring Techniques	Systematically improving code quality
14	Case Studies & Best Practices	Applying patterns in real-world scenarios

Remember: Design patterns are **tools, not rules**. Use them when they solve a real problem, not to demonstrate knowledge.

Module C: Final Project Requirements & Evaluation

Project Report Structure, Deliverables & Grading

Module C Outline

Final Project Requirements & Evaluation

1. Project Report Structure (MPR2)
2. Expected Deliverables
3. Evaluation Criteria and Rubric
4. Presentation Guidelines
5. Code Quality Expectations
6. Documentation Requirements

Project Report Structure (MPR2)

Required Report Sections

Section	Description
1. Title Page	Project name, team members, date, course information
2. Abstract	Brief summary of the project (150-300 words)
3. Introduction	Problem statement, motivation, objectives
4. Requirements Analysis	Functional and non-functional requirements
5. System Design	Architecture, UML diagrams (class, sequence, use case)
6. Implementation	Key implementation details, design patterns used
7. Testing	Test strategy, test cases, results

Section	Description
8. Conclusion	Summary, challenges faced, lessons learned
9. References	All sources cited properly
10. Appendices	Additional diagrams, full code listings (if needed)

Expected Deliverables

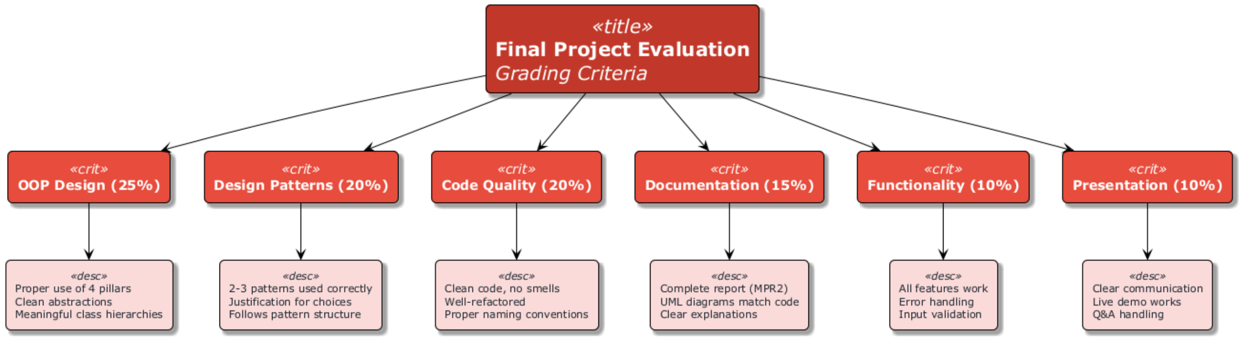
What You Must Submit

1. **Source Code**
   - Complete, compilable, and runnable project
   - Hosted on a version control system (e.g., GitHub)
   - Clean commit history showing team contributions
2. **Project Report (MPR2)**
   - Following the structure described above
   - Minimum 15 pages (excluding appendices)
   - PDF format
3. **UML Diagrams**
   - Class diagram (mandatory)
   - Sequence diagram for at least 2 key scenarios
   - Use case diagram
4. **Presentation Slides**
   - 10-15 slides covering key aspects
   - Demo screenshots or video
5. **Live Demonstration**
   - Working prototype shown during project presentation

Evaluation Criteria and Rubric

Grading Breakdown

Criterion	Weight	Excellent (90-100)	Good (70-89)	Satisfactory (50-69)	Poor (0-49)
OOP Design	25%	Proper use of all 4 pillars, clean abstractions	Good use of 3+ pillars, minor issues	Basic use of inheritance/encapsulation only	No clear OOP structure
Design Patterns	20%	3+ patterns used appropriately with justification	2 patterns used correctly	1 pattern attempted	No patterns used
Code Quality	20%	Clean code, no smells, well-refactored	Mostly clean, minor smells	Some code smells present	Many code smells, poor structure
Documentation	15%	Complete report, clear UML diagrams	Good report, minor diagram issues	Incomplete report or diagrams	Missing report or diagrams
Functionality	10%	All features work as specified	Most features work	Core features work	Major features broken
Presentation	10%	Clear, well-prepared, handles Q&A well	Good presentation, minor issues	Basic presentation	Unprepared, unclear



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Presentation Guidelines

How to Structure Your Presentation

Time	Section	Content
2 min	**Introduction**	Problem statement, motivation, team members
3 min	**Design**	Architecture overview, key UML diagrams
3 min	**Implementation**	Design patterns used, key technical decisions
5 min	**Demo**	Live demonstration of working features
2 min	**Conclusion**	Lessons learned, future work
5 min	**Q&A**	Answer questions from instructor and peers

Total Time: ~20 minutes per team

Code Quality Expectations

What We Look For

1. **Clean Code Principles**
   - Meaningful variable and method names
   - Short, focused methods (no Long Methods)
   - Proper code organization and package structure
2. **Design Patterns Usage**
   - At least 2-3 design patterns applied appropriately
   - Justification for why each pattern was chosen
   - Correct implementation following pattern structure
3. **Proper OOP**
   - Encapsulation: private fields with getters/setters where needed
   - Inheritance: meaningful class hierarchies (not forced)
   - Polymorphism: interfaces and abstract classes used effectively
   - Abstraction: clean separation of concerns
4. **No Code Smells**
   - No duplicate code
   - No long parameter lists
   - No feature envy or inappropriate intimacy

Documentation Requirements

UML Diagrams Required

Diagram	Purpose	Minimum Content
Class Diagram	Show system structure	All major classes, attributes, methods, relationships
Sequence Diagram	Show key interactions	At least 2 important use case flows
Use Case Diagram	Show system functionality	All primary actors and use cases

Report Requirements

- **PlantUML or UMPLE** preferred for diagram generation (not hand-drawn)
- Diagrams must be **consistent** with actual code
- All external libraries and frameworks must be **documented**
- Code snippets in the report should be **formatted** and **explained**

Module C – Takeaway

Final Project Requirements: Key Points

- Your project is evaluated on **design quality**, not just functionality
- Use at least **2-3 design patterns** with proper justification
- Submit **clean, well-documented code** with proper OOP structure
- UML diagrams must **match your actual implementation**
- The report should tell the **story** of your project: problem, design, implementation, testing

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Module D: Project Demonstration Guidelines

How to Present Your Project Effectively

Module D Outline

Project Demonstration Guidelines

1. How to Present Your Project
2. Demo Flow Recommendations
3. Q&A Preparation Tips
4. Common Pitfalls to Avoid
5. Grading Rubric for Demonstrations

How to Present Your Project

Preparation Checklist

☐ **Test everything** on the presentation machine beforehand
☐ **Prepare a backup plan** (screenshots, video recording) in case of technical issues
☐ **Know your code** – every team member should understand all parts
☐ **Prepare talking points** – do not read from slides
☐ **Practice the demo** at least 2-3 times
☐ **Time your presentation** to stay within limits
☐ **Assign roles** – who presents which section

Presentation Tips

- Start with the **big picture** before diving into details
- Show the **architecture** before showing code
- Use **diagrams** to explain complex interactions
- Keep slides **simple** – use them as visual aids, not scripts

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Demo Flow Recommendations

Recommended Demo Structure

```
1. SETUP (1 minute)
   - Show project structure briefly
   - Mention technologies and tools used

2. CORE FEATURES (3-4 minutes)
   - Demonstrate primary functionality
   - Show the most impressive features first
   - Follow a logical user workflow

3. DESIGN HIGHLIGHTS (1-2 minutes)
   - Show a specific design pattern in action
   - Explain WHY you chose that pattern
   - Show the corresponding UML diagram

4. CODE WALKTHROUGH (1-2 minutes)
   - Show one well-written class
   - Highlight clean code practices
   - Show how patterns are implemented

5. EDGE CASES (1 minute)
   - Show error handling
   - Demonstrate input validation
```

Q&A Preparation Tips

Common Questions to Expect

Category	Example Questions
Design Decisions	"Why did you choose the Observer pattern here instead of Mediator?"
Alternatives	"What other patterns did you consider and why did you reject them?"
Challenges	"What was the biggest technical challenge and how did you solve it?"
OOP Principles	"How does your design demonstrate the Open/Closed Principle?"
Testing	"How did you test this feature? What edge cases did you consider?"
Scalability	"How would your design handle 10x more users/data?"

Tips for Answering

- **Be honest** – if you do not know, say so and explain how you would find out
- **Be specific** – reference actual classes, methods, and patterns by name

- **Be concise** – answer the question directly, then elaborate if asked

Common Pitfalls to Avoid

What NOT to Do

Pitfall	Why It Is a Problem	How to Avoid
No backup plan	Technical failures happen	Record a demo video beforehand
Reading from slides	Shows lack of preparation	Use slides as visual aids only
Showing too much code	Overwhelms the audience	Show only key snippets
Skipping the design	Misses the main evaluation point	Spend at least 30% on design
Unequal participation	Shows poor teamwork	Ensure every member presents
Ignoring time limits	Disrespectful, loses points	Practice with a timer
Using patterns incorrectly	Worse than not using them	Understand each pattern fully
No error handling in demo	Crashes look unprofessional	Test all demo paths beforehand

Grading Rubric for Demonstrations

How Demos Are Evaluated

Criterion	Weight	Description
Technical Depth	30%	Demonstrates understanding of OOP concepts, design patterns, and code quality
Functionality	25%	Features work correctly and as described in the report
Presentation Quality	20%	Clear communication, good structure, professional delivery
Design Justification	15%	Can explain WHY design decisions were made, not just WHAT was done
Q&A Response	10%	Handles questions competently and honestly

Grade Descriptors

Grade	Description
A (90-100)	Exceptional design, flawless demo, deep understanding shown in Q&A
B (80-89)	Good design, working demo with minor issues, solid Q&A
C (70-79)	Adequate design, demo works for core features, basic Q&A
D (60-69)	Minimal design effort, demo has significant issues, weak Q&A
F (<60)	Poor or missing design, demo fails, unable to answer questions

Module D – Takeaway

Project Demonstration: Key Points

- **Prepare thoroughly** – practice the demo multiple times
- **Always have a backup** – record a video of your demo
- **Focus on design** – the demo should showcase your OOP and pattern usage, not just features
- **Every team member** must be able to explain every part of the project
- **Anticipate questions** – prepare answers for common Q&A topics

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Module E: Final Exam Preparation

Exam Format, Key Topics & Study Guide

Module E Outline

Final Exam Preparation

1. Exam Format and Scope
2. Key Topics to Review
3. Sample Question Types
4. Study Resources and Recommendations

Exam Format and Scope

Final Exam Details

Aspect	Details
Duration	90 minutes
Format	Written exam (closed book)
Question Types	Multiple choice, code analysis, short answer, design problems
Scope	All topics from Weeks 1-14
Weight	As specified in the course syllabus

What to Bring

- Student ID
- Pen/pencil
- No electronic devices allowed

Key Topics to Review

High-Priority Topics

Priority	Topic	What to Know
High	4 Pillars of OOP	Definitions, examples, when to use each
High	Design Patterns (all 22)	Intent, structure, when to use, code examples

Priority	Topic	What to Know
High	UML Class Diagrams	Read and create class diagrams, understand relationships
High	Code Smells	Identify smells, know which refactoring to apply
Medium	Refactoring Techniques	Know the major techniques and their purposes
Medium	PlantUML	Read PlantUML syntax, understand generated diagrams
Medium	UMPLE	Understand associations, state machines, code generation
Medium	SOLID Principles	Definitions, examples, how they relate to patterns
Low	Specific pattern implementations	Detailed code for all 22 patterns
Low	All 66 refactoring techniques	Detailed steps for every technique

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Sample Question Types

Type 1: Multiple Choice

Example: Which design pattern ensures a class has only one instance?

a) Factory Method
b) Singleton
c) Prototype
d) Builder

Answer: b) Singleton

Sample Question Types (continued)

Type 2: Code Analysis

Example: Identify the design pattern used in the following code:

```
public interface Logger {
    void log(String message);
}

public class FileLogger implements Logger {
    public void log(String message) { /* write to file */ }
}

public class ConsoleLogger implements Logger {
    public void log(String message) { /* print to console */ }
}

public class LoggerFactory {
    public static Logger getLogger(String type) {
        if (type.equals("file")) return new FileLogger();
        if (type.equals("console")) return new ConsoleLogger();
        throw new IllegalArgumentException("Unknown type: " + type);
    }
}
```

Answer: Factory Method (Simple Factory variant) – creates objects without exposing creation logic to the client.

Sample Question Types (continued)

Type 3: Code Smell Identification

Example: Identify the code smell(s) in the following code and suggest a refactoring:

```java
public double calculatePrice(String type, int quantity, double unitPrice,
                             double discount, boolean isMember,
                             String couponCode, double taxRate) {
    // ... complex calculation
}
```

Answer: - **Code Smell:** Long Parameter List - **Refactoring:** Introduce Parameter Object – create a `PriceRequest` class to group related parameters.

Sample Question Types (continued)

Type 4: Design Problem

Example: You are designing a notification system that needs to: - Support multiple notification channels (email, SMS, push notification) - Allow adding new channels without modifying existing code - Let users subscribe/unsubscribe from notifications

Question: Which design pattern(s) would you use? Draw a UML class diagram and explain your choice.

Expected Answer: - **Observer Pattern** for subscribe/unsubscribe mechanism - **Strategy Pattern** for interchangeable notification channels - Should include a class diagram showing `NotificationService`, `Observer` interface, `NotificationChannel` strategy interface, and concrete implementations

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Study Resources and Recommendations

Recommended Study Plan

Day	Activity	Focus
Day 1	Review OOP fundamentals	4 pillars, SOLID principles
Day 2	Review Creational & Structural patterns	12 patterns: intent, when to use
Day 3	Review Behavioral patterns	10 patterns: intent, when to use
Day 4	Review Code Smells & Refactoring	22 smells, major refactoring techniques
Day 5	Practice problems	Sample questions, code analysis
Day 6	UML diagrams & PlantUML	Draw class diagrams, read PlantUML
Day 7	Full review	Go through all week summaries

Key Resources

- **Course slides** (Weeks 1-14)
- **RefactoringGuru**: https://refactoring.guru
- **Design Patterns (GoF Book)**: Gamma, Helm, Johnson, Vlissides

- **Clean Code**: Robert C. Martin

Module E – Takeaway

Final Exam Preparation: Key Points

- The exam covers **all topics from Weeks 1-15**
- Focus on **understanding concepts**, not memorizing code
- Practice **identifying patterns** in code snippets
- Practice **identifying code smells** and suggesting refactorings
- Be able to **draw UML class diagrams** for given scenarios
- Know **when to use** each pattern, not just what it is

Course Summary

What You Have Learned

```
CEN206 Object-Oriented Programming
|
|-- FOUNDATIONS (Weeks 1-7)
|   |-- OOP Concepts: Encapsulation, Inheritance,
|   |   Polymorphism, Abstraction
|   |-- UML Diagrams: Visual modeling of software systems
|   |-- PlantUML: Text-based diagram generation
|   |-- UMPLE: Model-oriented programming
|
|-- DESIGN PATTERNS (Weeks 9-11)
|   |-- Creational: 5 patterns for object creation
|   |-- Structural: 7 patterns for composition
|   |-- Behavioral: 10 patterns for communication
|
|-- CODE QUALITY (Weeks 12-14)
|   |-- Code Smells: 22 smells across 5 categories
|   |-- Refactoring: 66 techniques across 6 categories
|   |-- Best Practices: SOLID, Clean Code, Case Studies
|
|-- APPLICATION (Week 15)
    |-- Final Project: Applying all concepts together
    |-- Course Summary: Consolidating knowledge
```

Final Words

Key Principles to Carry Forward

1. **Think in objects** – model real-world entities with classes and relationships
2. **Design before coding** – UML diagrams save debugging time
3. **Use patterns wisely** – they are solutions to recurring problems, not goals themselves
4. **Keep code clean** – refactor continuously, eliminate smells early
5. **Follow SOLID** – these principles guide good OOP design
6. **Test your code** – untested code is unreliable code
7. **Document your design** – future you (and your team) will thank you

Good luck with your final projects and exams!

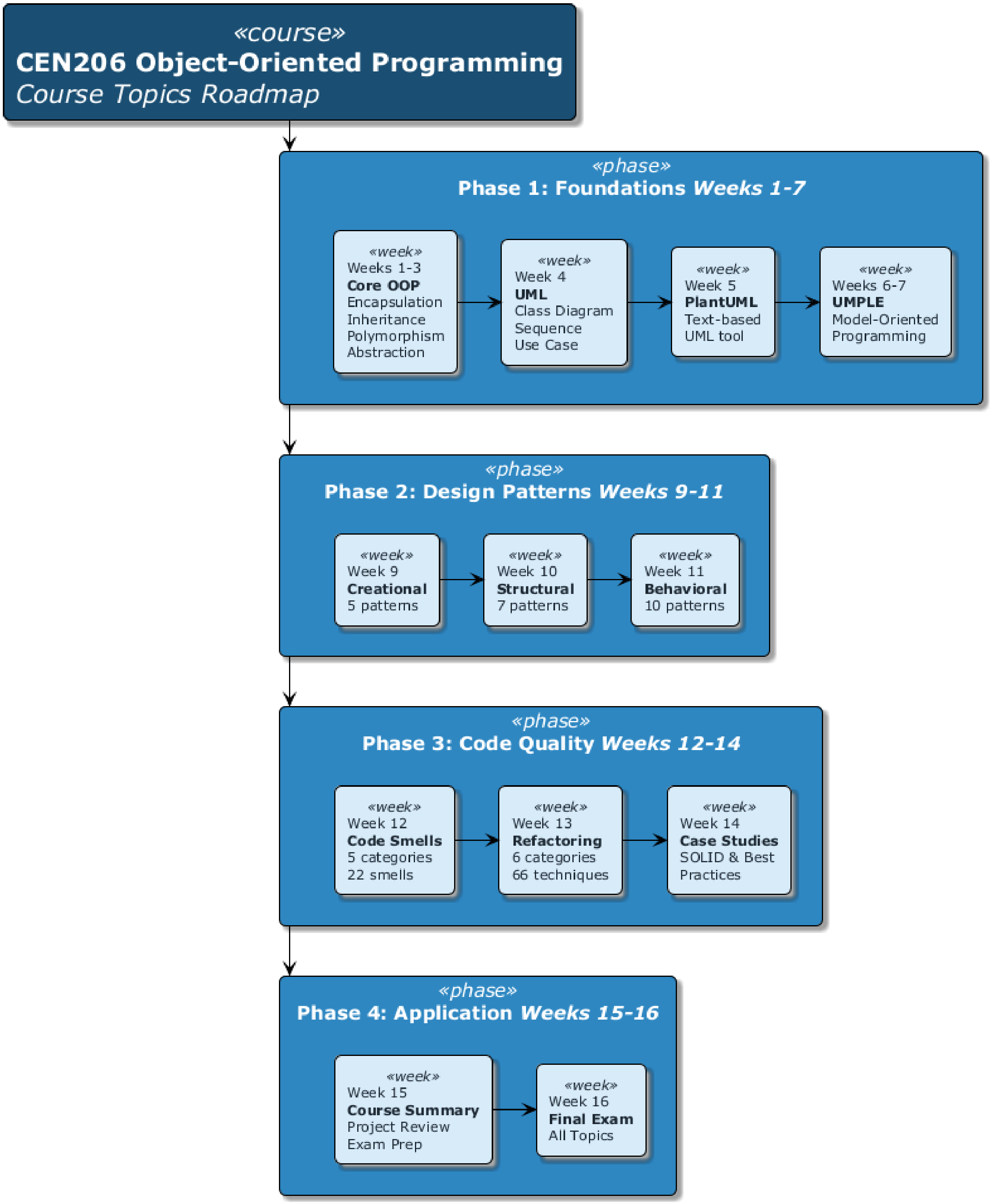
«course»
CEN206 Object-Oriented Programming
Course Topics Roadmap
«phase»
Phase 1: Foundations Weeks 1-7
«week» Weeks 1-3 Core OOP Encapsulation Inheritance Polymorphism Abstraction
«week» Week 4 UML Class Diagram Sequence Use Case
«week» Week 5 PlantUML Text-based UML tool
«week» Weeks 6-7 UMPLE Model-Oriented Programming
«phase»
Phase 2: Design Patterns Weeks 9-11
«week» Week 9 Creational 5 patterns
«week» Week 10 Structural 7 patterns
«week» Week 11 Behavioral 10 patterns
«phase»
Phase 3: Code Quality Weeks 12-14
«week» Week 12 Code Smells 5 categories 22 smells
«week» Week 13 Refactoring 6 categories 66 techniques
«week» Week 14 Case Studies SOLID & Best Practices
«phase»
Phase 4: Application Weeks 15-16
«week» Week 15 Course Summary Project Review Exam Prep
«week» Week 16 Final Exam All Topics

Figure 5: center

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$End - Of - Week - 15 - Module$