**Howard University**

**School of Engineering &Architecture**

**Department of Electrical Engineering & Computer Science**

**Large Scale / Object – Oriented Programming**

**Spring 2025**

**Final Exam**

100 pts.

**Name :\_\_\_\_\_Syrr Gordon\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**No collaboration is allowed on this exam, anything else is fair game.**

**Make sure you validate that all submission to your repo were successful**

***Question #1 (30 pts.)***

**Description:**

You are testing a ShoppingCart class that allows users to add and remove items, compute

total cost, and apply discount codes. Your task is to **write JUnit test cases** that verify the

behavior of this class under various conditions.

package org.howard.edu.lspfinal.question1;

import java.util.HashMap;

import java.util.Map;

/\*\*

\* Represents a simple shopping cart that allows adding items,

\* applying discount codes, and calculating the total cost.

\*/

public class ShoppingCart {

private Map<String, Double> items = new HashMap<>();

private double discountPercentage = 0.0;

/\*\*

\* Adds an item to the shopping cart.

\*

\* @param itemName the name of the item

\* @param price the price of the item (must be non-negative)

\* @throws IllegalArgumentException if price is negative

\*/

public void addItem(String itemName, double price) {

if (price < 0) {

throw new IllegalArgumentException("Price cannot be negative.");

}

items.put(itemName, price);

}

/\*\*

\* Calculates and returns the total cost of the cart,

\* applying any discounts currently in effect.

\*

\* @return total cost after applying discount

\*/

public double getTotalCost() {

double total = 0.0;

for (double price : items.values()) {

total += price;

}

double discountAmount = total \* (discountPercentage / 100.0);

return total - discountAmount;

}

/\*\*

\* Applies a valid discount code to the shopping cart.

\* Supported codes:

\* - "SAVE10": 10% discount

\* - "SAVE20": 20% discount

\*

\* @param code the discount code

\* @throws IllegalArgumentException if the code is invalid

\*/

public void applyDiscountCode(String code) {

switch (code) {

case "SAVE10":

discountPercentage = 10.0;

break;

case "SAVE20":

discountPercentage = 20.0;

break;

default:

throw new IllegalArgumentException("Invalid discount code.");

}

}

/\*\*

\* Returns the current discount percentage applied to the cart.

\* Useful for testing.

\*

\* @return the discount percentage (0.0 if no discount applied)

\*/

public double getDiscountPercentage() {

return discountPercentage;

}

}

**Requirements:**

Write a JUnit test class named ShoppingCartTest under the package org.howard.edu.lspfinal.question1.

You must:

1. Test adding items:
   * Valid items (name + price)
   * Invalid inputs (empty name, negative/zero price)
2. Test removing items:
   * Removing existing items
   * Attempting to remove non-existent items
3. Test total cost:
   * With and without discounts
   * With no items in the cart
4. Test applying discount codes:
   * Valid codes ("SAVE10", "SAVE20")
   * Invalid codes (e.g., "SAVE50", "")
5. Test cart size updates correctly after adding/removing

**Deliverables:**

A JUnit test class named ShoppingCartTest.java and implementation class ShoppingCart under package org.howard.edu.lspfinal.question1.

* All tests should compile and run without error

**Grading Criteria:**

Test for adding valid item **[3 pts.]**

Test for adding item with 0 price (expect exception) **[3 pts.]**

Test for adding item with negative price (expect exception) **[3 pts.]**

Test for applying "SAVE10"**[3 pts.]**

Test for applying "SAVE20" **[3 pts.]**

Test for applying invalid code (expect exception) **[3 pts.]**

Test total cost without discount **[4 pts.]**

Test total cost with discount **[5 pts.]**

Test total cost with empty cart **[3 pts.]**

Use the **@DisplayName** annotation to name your JUnit test cases according to the above.

***Question #2 (30 pts.)***

**Description:**

You are building a **Task Tracker** system for a team to manage and monitor their work. Each **Task** has the following properties:

1. A unique **name** (e.g., "Fix Bug #204")
2. An integer **priority** (lower number = higher priority)
3. A **status**: "TODO", "IN\_PROGRESS", or "DONE"

To make this system reliable and user-friendly, it must handle invalid operations gracefully by using **custom checked exception classes**.

You are to design and implement a TaskManager system in Java that includes:

1. **Add a New Task**
   * A task name must be **unique** (no duplicates).
   * If a task with the same name already exists, throw a custom exception called DuplicateTaskException.
   * This exception must include a helpful message, such as "Task 'Fix Bug #204' already exists."
2. **Retrieve a Task by Name**
   * If no such task exists, throw a custom exception called TaskNotFoundException.
   * The message should clearly indicate the missing task, e.g., "Task 'Deploy App' not found."
3. **Update the Status of an Existing Task**
   * Valid statuses are "TODO", "IN\_PROGRESS", and "DONE".
   * If the task does not exist, throw a TaskNotFoundException.
4. **Print All Tasks Grouped by Status**
   * For each status, print the list of tasks currently assigned to it.

**Requirements:**

1. Choose the appropriate design/data structure to implement your TaskManager.
2. Define and use two custom exception classes:
   1. DuplicateTaskException
   2. TaskNotFoundException

**Sample Driver:**

/\*\*

\* Driver class for testing the TaskManager system.

\*/

public class Driver {

package org.howard.edu.lspfinal.question2;

public static void main(String[] args) {

TaskManager manager = new TaskManager();

try {

manager.addTask("Fix Bug #204", 1, "TODO");

manager.addTask("Write Docs", 3, "TODO");

manager.addTask("Setup CI/CD", 2, "IN\_PROGRESS");

// Duplicate task

manager.addTask("Fix Bug #204", 4, "DONE");

} catch (DuplicateTaskException e) {

System.out.println("Error: " + e.getMessage());

}

try {

Task t = manager.getTaskByName("Write Docs");

System.out.println("Retrieved: " + t);

} catch (TaskNotFoundException e) {

System.out.println("Error: " + e.getMessage());

}

try {

manager.updateStatus("Write Docs", "DONE");

manager.updateStatus("Nonexistent Task", "IN\_PROGRESS");

} catch (TaskNotFoundException e) {

System.out.println("Error: " + e.getMessage());

}

// Print all tasks grouped by status

manager.printTasksGroupedByStatus();

}

}

**Sample Output:**

Error: Task 'Fix Bug #204' already exists.

Retrieved: Task{name='Write Docs', priority=3, status='TODO'}

Error: Task 'Nonexistent Task' not found.

Tasks grouped by status:

TODO:

Task{name='Fix Bug #204', priority=1, status='TODO'}

IN\_PROGRESS:

Task{name='Setup CI/CD', priority=2, status='IN\_PROGRESS'}

DONE:

Task{name='Write Docs', priority=3, status='DONE'}

**Deliverables:**

1. Use Sample Driver as your driver, call it Driver.java. Make sure your driver produces the same output from the supplied driver code.
2. **Javadoc comments** for all public classes and methods
3. All code should be uploaded to your repo. Solution should be under **package org.howard.edu.lspfinal.question2**

**Grading Criteria:**

1. **15 points**. For correctly implementing addTask, getTaskByName, updateStatus, and printTasksGroupedByStatus. Task names are unique, and status updates work as expected.
2. **5 points**. For proper implementation of custom exceptions
3. **5 points**: For clear, concise, and correct Javadoc for all public classes and methods.
4. **5 points**: correct implementation of the provided driver.

***Question #3 (30 pts.)***

You are designing part of a reporting subsystem for a business application. Different departments in the company—like Sales, Inventory, and others—need to generate reports. While each report has its own specific behavior, they all follow the same general workflow:

1. Load the data
2. Format the data
3. Print the final report

However, how these steps are implemented varies from one report to another.

Your task is to design and implement a solution that supports this structure while allowing future developers to add new types of reports with minimal duplication and maximum code reuse.

**Your Task:**

Design and implement a solution in Java that models this reporting system using object-oriented principles. The core reporting workflow should be reusable and extensible. Your design should:

* Capture the common structure of report generation in a base class.
* Allow each type of report to define its own implementation for the steps in the workflow.
* Demonstrate your design with at least two different kinds of reports that behave differently in each step.
* Show how a client might use your framework to create and generate each kind of report. Create a **Driver.java** class that demonstrates the correct behavior by producing the expected output (see below).

**Additional Notes:**

* Use your knowledge of **the Template Method design pattern** to structure your solution.
* Your design will be evaluated on clarity, adherence to object-oriented principles, and correct use of the pattern.
* All code should be uploaded to your repo. Solution should be under **package org.howard.edu.lspfinal.question3**

**Sample Output from Driver.java:**

**Loading sales data...**

**Formatting sales data...**

**Printing sales report.**

**Loading inventory data...**

**Formatting inventory data...**

**Printing inventory report.**

**Grading Criteria:**

Template Method Structure **[15 pts.]**

Working Driver with Output **[10 pts.]**

Code Quality & Clarity **[5 pts.]**

***Question #4 (10 pts.)***

During our discussions of design patterns over the last two weeks we’ve discussed many reasons why incorporating them into your software design can be advantageous. Briefly discuss one instance where using a design pattern may not be beneficial. Maximum points will be earned on this question for providing discussion presented during lecture and not on information obtained from the internet.

Solution should be under **package org.howard.edu.lspfinal.question4**. Embed answer into this document and upload to your repo. E-mail to [bwoolfolk@whiteboardfederal.com](mailto:bwoolfolk@whiteboardfederal.com) if you have difficulties uploading to your repo. Make sure you get confirmation that I received it.

**Grading Criteria:**

**10 points**. For correctly identifying discussion from lecture

**5 points.** For identifying a reasonable answer but it does not correlate to class/lecture discussion.

**Answer:**

During lecture, we spoke about how applying a design pattern to your code can often be beneficial. However, by extrapolating on the example you used in class of the Tea and Coffee classes, we can easily see how design patterns are not *always* advantageous.

In the example, we had a situation where we had to design a solution to prepare two drinks, Coffee and Tea, that have similar steps for preparation—namely, boiling water, pouring it into a cup, and adding condiments. At first, we implemented them as separate classes, but this was less than ideal as it created a lot of duplicated code.

Eventually, we moved onto using the Template Method pattern, where you define the skeleton of an algorithm and defer some steps to subclasses. To do so, we created a superclass called CaffeineBeverage that defined the overall algorithm, and left the subclasses to implement the steps that varied. Although this abstraction made sense in this scenario, it was only advantageous once the duplication became obvious. If we were to apply the pattern before any duplication was evident, we would have introduced unnecessary complexity to our software.

To understand why premature application of the Template Pattern is not ideal, we have to first understand that duplication is not always an issue at first. When dealing with two small classes like Tea and Coffee, the total amount of repeated code is really only two lines:

boilWater();

pourInCup();

That’s only two lines of repeated code in two places. Duplicate code like this is typically harmless, easy to read, and easy to change in both places if needed. In a case like this, implementing an entire design pattern (and the superclass, abstract methods, and new subclasses that it necessitates) might not save time, but rather cause more work for you—it takes more time and effort to overhaul your software to implement a design pattern than it does to leave the harmless and small instance of duplication.

Now, however, suppose we needed to add other beverages, like hot chocolate, green tea, and espresso. In this case, duplication would become especially painful; there’d be way more than the mere two duplicate lines we had before. In this scenario, the Template Method makes sense because it allows us to centralize the shared code and use the subclasses to override the specifics.

Like we discussed in class, design patterns are meant to solve **real, recurring problems**. Using a pattern preemptively can result in code that’s harder to read, maintain, and explain, especially for smaller or beginner-level projects. As you said, Professor, **patterns are tools, not decorations**, and should only be used when the problem truly calls for it.