

# Object-Oriented Design (CS 5004 / CS 5005)

Graduate Course, Khoury College of Computer Sciences

Northeastern University, Vancouver Campus

Spring 2023 Semester

*We acknowledge that the land on which we gather is the unceded territory of the Coast Salish Peoples, including the territories of the xʷməθkʷəṽəm (Musqueam), Skwxwú7mesh (Squamish), and səlilwətaʔ / Selilwitulh (Tsleil-Waututh) Nations.*

## Class Hours

Section 01: Monday 2:30 pm – 4:30 pm / Wednesday 2:30 pm – 4:30 pm (Pacific Time)

Section 02: Monday 5:00 pm – 7:00 pm / Wednesday 5:00 pm – 7:00 pm (Pacific Time)

Class Location: West Georgia 1426

Instructor: Lino Coria

Email: [l.coria@northeastern.edu](mailto:l.coria@northeastern.edu)

## Course Description

The course provides an intensive tour of class-based program design and the design of abstractions that support the design of reusable software and libraries. It reviews typical object-oriented concepts such as information hiding, encapsulation and various forms of polymorphism. It contrasts the use of inheritance and composition as dual techniques for software reuse. It provides a deeper understanding of object-oriented design using the use of graphical design notations such as UML and object-oriented design patterns. It also examines the relationship between algorithms and data structures, as well as basic techniques for analyzing algorithm complexity. Finally, it emphasizes on testing, specifically unit testing of components.

*“Think first, experiment later”*

The curiosity to ask questions, try out new things and the motivation to go above and beyond is essential to extract maximum benefit from this course. This is a programming-intensive course, but it also emphasizes careful design and thorough testing.

### Course Prerequisites

The course is suitable for students in the ALIGN MS in CS program. It assumes that students have been introduced to the basic principles of program design and computation in CS 5001 Intensive Fundamentals of Computer Science.

### Course Objectives

By the end of this course, you should be able to:

1. Design an object-oriented solution to small and moderately sized problems
2. Implement a given object-oriented design in the Java programming language
3. Generate appropriate documentation for developed solutions
4. Design unit tests for a given component and implement them
5. Create, refine, and express a design in graphical notation such as UML diagrams
6. Explore existing documentation to describe and use existing libraries and frameworks

### Course Structure

The course consists of 14 modules:

1. Data definitions, Classes, and Testing in Java
2. Methods for Simple Classes and Exceptions
3. Representing More Complex Forms of Data
4. Recursive Data Structures
5. Equality and Comparison
6. Hierarchical Data Representations, Uses and Sightings in Java
7. Design of Larger, More Complex Programs with Model, View, Controller
8. Design of Model
9. Controller and its Uses
10. Views
11. Art of Design – Inheritance vs. Composition
12. Art of Design – Iterator Design Pattern
13. Art of Design – Strategy Pattern
14. Art of Design - Adapters

Every two weeks, will follow the same format (starting on week 2 and allowing small shifts when the due date is on a holiday):

| Day     | Time       | Deliverable              |
|---------|------------|--------------------------|
| Monday  | 12 PM      | Individual quizzes due   |
|         | Class time | Team quizzes due         |
| Tuesday | 11:59 PM   | Personal reflections due |
| Friday  | 11:59 PM   | Labs due                 |
|         |            | Homework due             |
|         |            | Project due              |

| Week | Sunday             | Monday             | Tuesday        | Wed    | Thursday | Friday    | Saturday |
|------|--------------------|--------------------|----------------|--------|----------|-----------|----------|
| 1    | 08-Jan             | 09-Jan             | 10-Jan         | 11-Jan | 12-Jan   | 13-Jan    | 14-Jan   |
|      |                    | Study Module 1     |                |        |          |           |          |
|      |                    |                    |                |        |          |           |          |
|      |                    |                    |                |        |          |           |          |
|      |                    |                    |                |        |          |           |          |
| 2    | 15-Jan             | 16-Jan             | 17-Jan         | 18-Jan | 19-Jan   | 20-Jan    | 21-Jan   |
|      |                    | Quiz 1 due         | Study Module 2 |        |          |           |          |
|      |                    | Work on Lab 1      |                |        |          |           |          |
|      |                    |                    |                |        |          |           |          |
|      |                    |                    |                |        |          |           |          |
| 3    | 22-Jan             | 23-Jan             | 24-Jan         | 25-Jan | 26-Jan   | 27-Jan    | 28-Jan   |
|      |                    | Quiz 2 due         | Study Module 3 |        |          |           |          |
|      | Work on Lab 1      |                    |                |        |          | Lab 1 due |          |
|      |                    | Work on Homework 1 |                |        |          |           |          |
|      |                    |                    |                |        |          |           |          |
| 4    | 29-Jan             | 30-Jan             | 31-Jan         | 01-Feb | 02-Feb   | 03-Feb    | 04-Feb   |
|      |                    | Quiz 3 due         | Study Module 4 |        |          |           |          |
|      |                    | Work on Lab 2      |                |        |          |           |          |
|      | Work on Homework 1 |                    |                |        |          | HW 1 due  |          |
|      |                    |                    | Reflection 1   |        |          |           |          |
| 5    | 05-Feb             | 06-Feb             | 07-Feb         | 08-Feb | 09-Feb   | 10-Feb    | 11-Feb   |
|      |                    | Quiz 4 due         | Study Module 5 |        |          |           |          |

|    |                    |                    |                 |            |                |           |        |
|----|--------------------|--------------------|-----------------|------------|----------------|-----------|--------|
|    | Work on Lab 2      |                    |                 |            |                | Lab 2 due |        |
|    |                    | Work on Homework 2 |                 |            |                |           |        |
|    |                    |                    |                 |            |                |           |        |
| 6  | 12-Feb             | 13-Feb             | 14-Feb          | 15-Feb     | 16-Feb         | 17-Feb    | 18-Feb |
|    |                    | Quiz 5 due         | Study Module 6  |            |                |           |        |
|    |                    | Work on Lab 3      |                 |            |                |           |        |
|    | Work on Homework 2 |                    |                 |            |                | HW 2 due  |        |
|    |                    |                    |                 |            |                |           |        |
| 7  | 19-Feb             | 20-Feb             | 21-Feb          | 22-Feb     | 23-Feb         | 24-Feb    | 25-Feb |
|    |                    |                    |                 | Quiz 6 due | Study Module 7 |           |        |
|    | Work on Lab 3      |                    |                 |            |                | Lab 3 due |        |
|    |                    | Work on Homework 3 |                 |            |                |           |        |
|    |                    |                    |                 |            |                |           |        |
| 8  | 26-Feb             | 27-Feb             | 28-Feb          | 01-Mar     | 02-Mar         | 03-Mar    | 04-Mar |
|    |                    | Quiz 7 due         | Study Module 8  |            |                |           |        |
|    |                    |                    | Work on Lab 4   |            |                |           |        |
|    | Work on Homework 3 |                    |                 |            |                | HW 3 due  |        |
|    |                    |                    | Reflection 2    |            |                |           |        |
|    | 05-Mar             | 06-Mar             | 07-Mar          | 08-Mar     | 09-Mar         | 10-Mar    | 11-Mar |
|    | Spring Break       |                    |                 |            |                |           |        |
| 9  | 12-Mar             | 13-Mar             | 14-Mar          | 15-Mar     | 16-Mar         | 17-Mar    | 18-Mar |
|    |                    | Quiz 8 due         | Study Module 9  |            |                |           |        |
|    | Work on Lab 4      |                    |                 |            |                | Lab 4 due |        |
|    |                    | Work on Homework 4 |                 |            |                |           |        |
|    |                    |                    |                 |            |                |           |        |
| 10 | 19-Mar             | 20-Mar             | 21-Mar          | 22-Mar     | 23-Mar         | 24-Mar    | 25-Mar |
|    |                    | Quiz 9 due         | Study Module 10 |            |                |           |        |
|    |                    | Work on Lab 5      |                 |            |                |           |        |
|    | Work on Homework 4 |                    |                 |            |                | HW 4 due  |        |
|    |                    |                    |                 |            |                |           |        |
| 11 | 26-Mar             | 27-Mar             | 28-Mar          | 29-Mar     | 30-Mar         | 31-Mar    | 01-Apr |
|    |                    | Quiz 10 due        | Study Module 11 |            |                |           |        |
|    | Work on Lab 5      |                    |                 |            |                | Lab 5 due |        |

|    |                           |                           |                         |               |        |            |        |
|----|---------------------------|---------------------------|-------------------------|---------------|--------|------------|--------|
|    |                           | Work on Part 1 of Project |                         |               |        |            |        |
|    |                           | Presentations             |                         | Design Review |        |            |        |
| 12 | 02-Apr                    | 03-Apr                    | 04-Apr                  | 05-Apr        | 06-Apr | 07-Apr     | 08-Apr |
|    |                           | Quiz 11 due               | Study Module 12         |               |        |            |        |
|    |                           | Work on Lab 6             |                         |               |        |            |        |
|    | Work on Part 1 of Project |                           |                         |               |        | Part 1 due |        |
|    |                           | Presentations             | Reflection 3            |               |        |            |        |
| 13 | 09-Apr                    | 10-Apr                    | 11-Apr                  | 12-Apr        | 13-Apr | 14-Apr     | 15-Apr |
|    |                           | Quiz 12 due               | Study Modules 13 and 14 |               |        |            |        |
|    | Work on Lab 6             |                           |                         |               |        | Lab 6 due  |        |
|    |                           | Work on Part 2 of Project |                         |               |        |            |        |
|    |                           | Presentations             |                         | P1 CW         |        |            |        |
| 14 | 16-Apr                    | 17-Apr                    | 18-Apr                  | 19-Apr        | 20-Apr | 21-Apr     | 22-Apr |
|    |                           | Quiz 13 due               |                         |               |        |            |        |
|    |                           |                           |                         |               |        |            |        |
|    | Work on Part 2 of Project |                           |                         |               |        | Part 2 due |        |
|    |                           | Presentations             |                         |               |        |            |        |
| 15 | 23-Apr                    | 24-Apr                    | 25-Apr                  | 26-Apr        | 27-Apr | 28-Apr     | 29-Apr |
|    |                           |                           |                         |               |        |            |        |
|    |                           |                           |                         |               |        |            |        |
|    |                           | P2 CW                     |                         |               |        |            |        |
|    |                           |                           |                         |               |        |            |        |

Note: This calendar is subject to change. Please obtain updated version via Canvas.

### Pre-class Work

This course, as well as other MSCS courses at the Vancouver campus of Northeastern University, will be taught using a pedagogical technique known as the Flipped/Hybrid classroom. This approach makes the most of our precious class time by eliminating the standard lecturing model, where course material is *introduced* to the students during class, usually via a lengthy PowerPoint presentation. In our Flipped/Hybrid classroom, you will come to class having already completed several readings where you will be introduced to the course material and complete a pre-class quiz. And then during class, you will *apply* your understanding of these core concepts through carefully chosen problems and activities, which will enable you to *solidify* your knowledge.

Flipped/Hybrid classrooms require much more focus and preparation time, for both the instructor and the students. After all, it is much easier for the instructor to read a set of pre-prepared slides and for the students to passively observe and listen. But on our campus, we will devote our class time to the computational thinking process: resolving obstacles, developing conceptual understanding, communicating solutions supported by evidence, and creating efficient algorithms that solve our problem. Through this process, you will better develop your confidence, creativity, and critical-thinking skills, preparing you to become *computer scientists* (not just programmers).

For this course to be a meaningful learning experience, you will need to come to each class well-prepared, with all assigned readings and videos complete, as well as your individual quiz finished to the best of your ability. This emphasis on pre-class work is the reason our class meets for only 2 hours of “lecture” each week, compared to other four-credit courses at Northeastern that meet for 3.25 hours each week. If you do not complete the pre-class work, you will have a challenging time following the in-class activities.

### In-class Work

It is extremely important for you to become engaged in this course. Like most programming courses, we are asking you to change the way you think so that you can express your thoughts to a computer. While you have had some success with this type of thing before in previous courses, we are asking you to learn yet another language and programming paradigm for expressing solutions to problems. This is not an easy task.

Students are expected to keep up with the material as it is released each week, to ask for help when they need it (or when feeling overwhelmed), to complete assignments on time, to actively participate in class discussion, to respect your classmates’ right to learn, and to refrain from disruptive behavior.

While this course is designed for you to succeed, you will not unless you put the time in. In general, you should be prepared to spend 3-4 hours per credit hour. This means that you should plan to spend a minimum of 12-16 hours per week on this course.

### Course Assessment

Final grades will reflect students’ effort and performance. The course grade will be based on the following:

#### Quizzes

|                          |    |
|--------------------------|----|
| Individual Quizzes (x12) | 6% |
| Team Quizzes (x12)       | 6% |

|                                    |             |
|------------------------------------|-------------|
| <b>Labs (x6)</b>                   | <b>24%</b>  |
| <b>Homework (x4)</b>               | <b>20%</b>  |
| <b>Project</b>                     |             |
| Style and best practices (x2)      | 10%         |
| Report (x2)                        | 12%         |
| Design Review                      | 4%          |
| Code Walks (x2)                    | 8%          |
| <b>Design Pattern Presentation</b> | <b>7%</b>   |
| <b>Personal Reflections (x3)</b>   | <b>3%</b>   |
| <b>Total</b>                       | <b>100%</b> |

There are 13 individual quizzes and 13 team quizzes. However, the individual quiz with the lowest grade will be dropped which means only 12 quizzes will be considered for the final grade. Same thing applies for the team quizzes.

### Late/Makeup Policy

- All assignments have a specific due date and time.
- Reflections will not be accepted late.
- Make-up quizzes (team or individual) will not be given.
- Lab, homework, and project submissions will be docked 25% for every day that they are late.

If there is a legitimate reason a student will not be able to complete an assignment on time, then they should contact the instructor beforehand. Under extreme circumstances, as decided on a case-by-case basis by the instructor, students may be allowed to make up assignments without first informing the instructor.

### Regrade Policy

If you have a question about a grade, please contact the grader of the assignment. If the grading was done via [Gradescope](#), you can request regrading directly from the platform. If the situation was not resolved, please contact the instructor by email. Provide the name of the course and the section number. Be specific about the part of the assignment that needs to be reviewed (example: Project 3, question 2.1) and why you think the problem has not been resolved yet.

### Grade Calculations

Grades will be calculated on an absolute basis: there will be no overall curving. The mapping of raw point totals to letter grades is given below. Please note that these grade boundaries may move slightly

at the discretion of the instructor, but the grade boundary for A is unlikely to change.

|                |    |
|----------------|----|
| 93.00 – 100.00 | A  |
| 90.00 – 92.99  | A- |
| 86.00 – 89.99  | B+ |
| 82.00 – 85.99  | B  |
| 77.00 – 81.99  | B- |
| 73.00 – 76.99  | C+ |
| 69.00 – 72.99  | C  |
| 65.00 – 68.99  | C- |
| 0.00 – 64.99   | F  |

## Course Materials

The required reading for this course is provided on the course Canvas page. Students are expected to read each module's materials as well as view any of the supplemental videos before attempting that module's assignments. Trying to do the assignments without reading the posted material or watching the videos will make the assignments much harder than they are designed to be. For some of you, it will be necessary for you to review the module's material more than once to understand the material.

## Textbooks

In addition to the material available on Canvas, there are four recommended textbooks for this class:

- Absolute Java, 6th Edition by Walter Savitch and Kenrick Mock, 2015. ISBN: 978- 0134041674. This is a text for students who need a background in Java and do not have it. The book is more thorough than the Java tutorials [on Oracle's website](#).
- Effective Java, 3rd Edition by Joshua Block, 2018. ISBN: 978-0134685991. For students who have some Java experience, this text is a great resource for delving deeper into best practices. This text is freely available to students through Northeastern University's library website.
- Head-First Design Patterns by Eric Freeman, et al, 2004. ISBN: 978-0596007126. This is an easy-going and fun introduction to design patterns with examples in Java. This text is freely available to students through Northeastern University's library website.
- Design Patterns: Elements of Reusable Object-Oriented Software by Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides, 1994. ISBN: 978- 0201633610. This is the standard reference for object-oriented design patterns that belongs on every computer scientist's bookshelf. Additionally, it is freely available to students through Northeastern University's library website.



## Computing Environment

You will want to download and install a professional integrated development environment (IDE) to write your programs this semester. The introductory module shows you how to work with IntelliJ. It is freely available and can be downloaded from [JetBrains' website](#).

## Handing in Assignments

[Gradescope](#) will be used for student submission of most assignments. To use this platform, students will need to have a Northeastern email address. Answers to the most frequent questions can be found on the [Help section](#).

For some assignments, *Gradescope* will be configured to automatically assess code quality and correctness. Students can learn from the feedback and resubmit their code if it is prior to the deadline.

## Office Hours

Lino Coria: Monday 1 PM – 2 PM, Wednesday 1 PM – 2 PM (Pacific Time)

Office Hours will be held remotely. Because of this, please use [Microsoft Bookings](#) to book an appointment. Students can also e-mail to schedule office hours outside of the scheduled time if necessary. Also note that remote connectivity problems may cause quality of service that are beyond our control. If those issues arise, we reserve the right to end/suspend the online hours at our discretion.

## Other Policies

### Academic Honesty

You are expected to read, understand, and follow the [University's policy on Academic Integrity](#). Each student is expected to do his or her own work. Violations of academic integrity will result in a zero on the corresponding assignment along with harsher penalties for more widespread problems. An Academic Integrity Report will be submitted by the instructor to the Office of Student Conduct and Conflict Resolution (OSCCR).

Here are a few examples of academic dishonesty:

- Working with one or more partners on an assignment where not allowed.
- Submitting a copy of work done by another student, with or without their knowledge.
- Submitting work that was primarily found on the web or provided by someone else outside of this class.

- Submitting work by anybody who took this course in the past whether the course was here at Northeastern or at another campus or institution.
- Providing or receiving significant help to another student on an assignment.

General discussions with other students are okay but should be done away from the computer, leaving only memories.

If you are unsure about the plagiarism policy, **please ask me!**

### Accommodations

The goal is for every student to succeed in this course. If you require any accommodations (e.g., childcare during class hours, extra time to complete assignments, support for a disability), let me know immediately so that we can work out appropriate arrangements. Speak to me at the end of class or contact me by e-mail, and we will set up a time to meet during the first week of the course. I look forward to learning how I can be of service to you.

Students who have disabilities who wish to receive academic services and/or accommodations should visit the [Disability Resource Center](#) (DRC) or call 844-688-6287.

If you have already done so, please provide your letter from the DRC to the instructor early in the semester to arrange those accommodations.

### Attendance and Participation

It is expected that you attend every class in person and participate. If you must miss a class for any reason (e.g., illness, family emergency, religious observance), contact me by e-mail. Regardless of the reason, it is your responsibility to catch up on the material you have missed and obtain the notes from a classmate (not from me). Missing one lecture means you also miss that week's team quiz.

Since some students are facing visa delays, we will offer the option to attend the class virtually from the beginning of the course and until January 30<sup>th</sup>. This option will not be available after this date.

Students who are absent repeatedly from class will be evaluated by faculty responsible for the course to ascertain their ability to achieve the course objectives and to continue in the course.

## Classroom Conduct

The classroom principles that we will follow in the classroom are transparency, equity and inclusion, participation, active dialog, and constructive critique. Students are expected to support each other, learn from each other, and help each other grow. Students have the responsibility to conduct themselves in ways that will help them learn, yet that will not disrupt other students' learning. While each student will be working closely with their team members, you are also expected to engage with your classmates in a respectful, kind, and helpful manner.

In the class, we encourage asking questions, sharing ideas, and engaging in discussions related to the class topics. Sometimes discussions may steer away from the course content, and the course instructor will reserve the right to re-direct it back on track.

Giving and receiving feedback is one of the core activities in this class. When giving and receiving feedback, it is important to keep in mind that we give feedback because we want all projects to succeed. Our feedback will highlight parts that work well but also point out aspects that can be improved. The feedback should not be taken personally or seen as an attack on students' knowledge or capabilities. Thus, we will learn a craft of constructive feedback and practice it in the class regularly.

## Feedback

Your opinions are very important to me. All students are strongly encouraged to use the Teacher Rating and Course Evaluation (TRACE) system, at <https://www.northeastern.edu/trace/>, to complete your course evaluations. A reminder about TRACE should arrive via email about two weeks before the end of the course.

In addition, I will be asking for your feedback at least once, about halfway through the semester. However, if you have concerns about the course, do not wait until you are asked. Please schedule a meeting with me, and we will discuss your concerns then.

## Expectations

1. Respect should be shown in all communications and interactions with faculty, staff, industry, peers, and all others on campus. This includes respecting the preferred methods and response times of faculty and staff.
2. Students come to class prepared and having engaged with the online course materials.
3. Students are to actively participate in course activities and discussion.
4. Any issues that arise should be communicated to the appropriate faculty or staff member proactively.
5. All course interaction including instruction, teamwork, TA advising, and course activities are to be done in English.

6. Students should come into the classroom with the goal of learning and have a “growth mindset”.

## Meetings

At any time during the course, if you have any concerns, speak to me at the end of class, or contact me by e-mail, and we will set up a one-on-one meeting at a mutually convenient time, either on campus or via Teams.

## Title IX Policy

Title IX of the USA Education Amendments of 1972 protects individuals from sex or gender-based discrimination, including discrimination based on gender-identity, in educational programs and activities that receive federal financial assistance.

Northeastern’s Title IX Policy prohibits Prohibited Offenses, which are defined as sexual harassment, sexual assault, relationship or domestic violence, and stalking.

The Title IX Policy applies to the entire community, including male, female, transgender students, faculty, and staff.

If you or someone you know has been a survivor of a Prohibited Offense, confidential support and guidance can be found through [University Health and Counseling Services](#) staff and the [Center for Spiritual Dialogue and Service clergy members](#). By law, those employees are not required to report allegations of sex or gender-based discrimination to the University.

Alleged violations can be reported to the Title IX Coordinator within The Office for Gender Equity and Compliance at: [titleix@northeastern.edu](mailto:titleix@northeastern.edu) and/or through NUPD 844-688-6287.

Reporting Prohibited Offenses to NUPD does NOT commit the victim/affected party to future legal action.

Faculty members are considered “responsible employees” at Northeastern University, meaning they are required to report all allegations of sex or gender-based discrimination to the Title IX Coordinator.

In case of an emergency, please call 911.

Please visit <http://www.northeastern.edu/titleix> for a complete list of reporting options and resources both on- and off-campus.