

# CS 475: Concurrent & Distributed Systems

## (Fall 2023)

## 1 Course Basics

### 1.1 Instructor

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### 1.2 Description

This course covers the principles and techniques behind the design of modern, reliable, and high-performance distributed systems. Topics include server design, network programming, concurrency and locking, consistency models and techniques, and fault tolerance. Modern techniques and systems employed at some of the largest Internet sites (e.g., Google, Facebook, Amazon) will also be covered. Through programming assignments, students will gain practical experience designing, implementing, and debugging real distributed systems.

### 1.3 Prerequisites

Students are required to have previously taken CS 367 (Computer Systems & Programming).

This is a programming-intensive course. You need to be comfortable with programming in one of the following languages including C, Python, Java. Knowing a language serves as a soft prerequisite and would get you prepared to learn a new language (if you haven't already) and do the programming assignments in this course.

This semester you will be learning a new language *Go* (<https://golang.org>) as all assignments will be in Go.

It is also not a good idea to take this class if your course/work schedule is already quite full.

### 1.4 Course Outcomes

Upon completion of this course, the students should be able to:

- To get an overview of practical, modern distributed systems, with an eye toward datacenter systems in particular.
- Demonstrate an understanding of the fundamental concepts in standard distributed systems techniques and infrastructure (RPC, consensus, fault tolerance, consistency, scalability).
- To learn how to approach, discuss, and communicate about difficult and technical subject matter.
- Demonstrate an ability to design and implement concurrent & distributed systems using modern technologies.

## 1.5 Topics

- Introduction
- Fundamentals
- Fault tolerance and consensus
- Consistency, scalability, transactions
- Big data processing
- Datacenter techniques
- Reasoning about system performance

## 1.6 Textbooks

There are no official textbooks. Required readings are (most frequently) in the form of research papers and/or selected textbook chapters. There are several books that might be useful, however:

- Distributed Systems 3rd edition (2017), by Maarten van Steen and Andrew S. Tenenbaum (suggested optional readings will most frequently be drawn from this book).  
Link: <https://www.distributed-systems.net/index.php/books/ds3>
- Operating Systems: Three Easy Pieces (OSTEP), by Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, Aug, 2018 (v 1.00)  
Link: <http://pages.cs.wisc.edu/~remzi/OSTEP>
- The Go Programming Language. Alan A. A. Donovan and Brian W. Kernighan (Web page).  
Link: <http://www.gopl.io>

## 1.7 Programming Assignments

You will learn how to use Go as we go. Details concerning the programming assignments (labs) will be presented in class. All students should have accounts on the VSE Unix cluster (aka zeus.vse.gmu.edu). Instructions and related links: <https://labs.vse.gmu.edu/index.php/FAQ/ClusterAccount>

## 1.8 Discussion Board: Piazza

- Announcements, discussion and GTA contacts will be on Piazza.
- All correspondence will go through Piazza. You can send private messages to the instructors (visible to all professors and GTAs) as well as post public questions visible to all students, collaborate on responses, and tag everything by topic.
- All instructors and TAs can view all material on Piazza.
- No sharing answers or code solutions to assignments on the discussion board. You can include code in private posts to the instructors. See Honor code section below for more details.
- Email course staff only for logistical issues such as meeting outside of office hours, missing lab/lecture, grading disputes, medical situations, etc. Do not e-mail course staff about programming problems; use the discussion board. Project help questions sent via email are of extremely low priority, as they were sent to the wrong place and will most likely be responded to with “please post on Piazza”.
- The discussion board on Piazza is required reading for all projects. You MUST read the discussion board for clarifications and project updates.

## 1.9 Blackboard

- Course schedule, course syllabus, description of assignments, lab and lecture slides will be posted on Blackboard.
- All programming assignments will be submitted (per published deadlines) via Blackboard.
- All grades will be posted to Blackboard.

## 1.10 Office Hours

- Students must make significant, individual effort on all projects before coming to see a GTA/professor. Waiting until the last minute, in the expectations that the entire project will be explained in one office hours session, is not feasible.
- Office hours are often crowded - do not rely on them for last minute help, as we cannot guarantee that we will be able to spend significant time with every student. You can also use the discussion board for posting questions.

# 2 Grading

Your grade will be calculated as follows:

- 40% projects
- 10% quizzes and in-class activities
- 15% homework
- 15% midterm exam
- 20% final exam

The final grade is computed according to the following rules:

- A+:  $\geq 97\%$ ; A: [93%, 97%]; A-: [88%, 93%)
- B+: [85%, 88%); B: [81%, 85%); B-: [77%, 81%)
- C+: [74%, 77%); C: [70%, 74%); C-: [65%, 70%)
- D: [60%, 65%)
- F:  $< 60\%$

There will be no make-up or extra-credit assignments at the end of the semester; your grade should be a measure of your semester-long progress.

## 2.1 Collaboration Policy

Students must work individually on all programming assignments. We encourage you to have high-level discussions with other students in the class about the assignments.

However, we require that when you turn in an assignment, it is only your work. That is, copying any part of another student's assignment is strictly prohibited. Anything that you hand in, whether it is a written problem or a computer program, must be written in your own words. If you base your solution on any other written solution, you are cheating.

Never look at another student's code or share your code with any other student. You must not make your code public (on GitHub/GitLab/Piazza/Pastebin or by any other means). It is your responsibility to lock your computers with a password, to not post your code to websites that are publicly accessible, to guard your USB drives and computers, to not upload your files to someone else's computer, etc. You are liable for any access gained to your code.

### 2.1.1 AI-assisted tool usage policy

ChatGPT or other Generative-AI models may be used (but **not encouraged**) in this course as an assistant in projects and homework assignments. Any use must follow the fundamental principles of the Honor Code and include the following statement with assignment submission:

**The ideas in this submission are original and were generated by (my name). ChatGPT (or name other Generative-AI model) was used as an editorial/coding assistant, however, I take full responsibility for the originality and accuracy of the content.**

Risk accompanies use of any powerful tool. Students are cautioned that sharing their own original ideas with Generative-AI models can lead to loss of control and ownership of those ideas and coding. Furthermore, in terms of learning in this class, students who replace their own learning and project work with materials prepared by Generative-AI models:

- Surrender control over the material's truthfulness and accuracy, and violate the university's Honor Code.
- Sacrifice the opportunity to acquire the knowledge, skills, and critical thinking taught in the course.
- Risk being unable to perform to expectations when Generative-AI models are unavailable, such as in exams.
- Ultimately endanger their employability if they are unable to produce work other than that produced by Generative-AI models.

## 2.2 Late Policy

The deadline of assignments and course project is 11:59pm New York time of the due date.

10% will be deducted for late assignments each day after the due date. That is, if an assignment is late, we will grade it and scale the score by 0.9 if it is up to one day late, by 0.8 if it is up to two days late, and by 0.7 if it is up to three days late.

Late assignments will only be accepted for 3 days after the due date. Assignments submitted more than 3 days late will receive a zero. If you're worried about being busy around the time of a HW submission, please plan ahead and get started early.

Each student gets two "Emergency Day" tokens, which are automatically used by late submissions to avoid the degrading penalty. Unused emergency-tokens will be worth 0.25% bonus to a student's overall grade at the semester's end.

Blackboard being unavailable is not an excuse for turning in a late assignment; in the rare situation that the website is somehow unavailable or giving the student an error, the student **MUST** email their submission to the instructor or GTA before the deadline, otherwise it will be considered late. Catastrophic computer failure will not be cause for an extension. Use a backup service such as DropBox (or any cloud service), emailing yourself, making multiple rounds of submissions to Blackboard, whatever it takes.

## 2.3 Contested Grades

If you feel points have been incorrectly deducted, contact the grader. For all programming assignments and lab work, that is your GTA. For exams, that is your professor.

Contesting of grades on any/all submissions must be requested within one week of receiving the grade (on Blackboard). No grade changes will be considered after that deadline.

# 3 University & Departmental Policies

## 3.1 Academic integrity

All students must adhere to the GMU Honor Code (<https://oai.gmu.edu/mason-honor-code>) and the Computer Science Department's Honor Code (<http://cs.gmu.edu/resources/honor-code>) Policies. Only high-level discussion is allowed. The students are supposed to work individually on the homework, assignments and

course project. Anything you hand in, should be only written in your words and show your own efforts. We reserve the right to use MOSS (<http://theory.stanford.edu/aiken/moss>) to detect plagiarism. **Violation of the Honor Code will result in an F.**

### 3.2 Privacy

All course materials posted to Blackboard or other course sites are private; by federal law, any materials that identify specific students (via their name, voice, or image) must not be shared with anyone not enrolled in this class. Video recordings of class meetings that include audio or visual information from other students are private and must not be shared. Live Video Conference Meetings (e.g. Collaborate or Zoom) that include audio or visual information from other students must be viewed privately and not shared with others.

### 3.3 Non-Discrimination and Inclusiveness

We are committed to providing an educational environment free from any discrimination on the basis of race, color, religion, national origin, sex, disability, veteran status, sexual orientation, gender identity, gender expression, age, marital status, pregnancy status, or genetic information. If you feel there has been a violation of the University's policies on this, please contact GMU's Office of Diversity, Equity, and Inclusion (703-993-8730; [dei@gmu.edu](mailto:dei@gmu.edu)).

Gender identity and pronoun use: If you wish, please share your name and gender pronouns with us and we will attempt use them to address you in class and via email. You can update your chosen name and pronouns here: <https://registrar.gmu.edu/Updating-chosen-name-pronouns>.

### 3.4 Sexual Harassment, Sexual Misconduct, and Interpersonal Violence

All faculty members are designated "Responsible Employees", and are required to report all disclosures of sexual assault, interpersonal violence, and stalking to Mason's Title IX Coordinator per university policy 1412. If you wish to speak with someone confidentially, please contact the Student Support and Advocacy Center (703-380-1434) or Counseling and Psychological Services (703-993-2380). You may also seek assistance from Mason's Title IX Coordinator (703-993-8730; [titleix@gmu.edu](mailto:titleix@gmu.edu)).

### 3.5 Auditing Policy

Auditors must be admitted Mason students. Students who wish to audit a class for no grade or credit must submit a course audit form with the instructor's signature to the Registrar's Office before the last day to drop a course. After the drop date has passed, students may not alter their status from credit to audit.

For admitted students over 60, there is a form they can complete to waive the Tuition. However, they still must apply to Mason, be accepted by Mason and then register to the course.

## 4 Campus Resources

### Disability Services:

- Due to the size of the class, individual professors and GTAs cannot support students with injuries or disabilities on an ad-hoc basis. We ask that all accommodations for such conditions be arranged through GMU's Office of Disability Services (<http://ds.gmu.edu>).
- Students with a physical or learning disability which is already documented with the Office of Disability Services) should speak with the professor ASAP to discuss their approved accommodations. Even if you don't know whether you plan on utilizing the accommodations for any assignment/test, you need to make sure you and your professor are working together from the beginning of the semester to ensure your success in the class.

- Students with a physical or learning disability who have not yet registered with the Office of Disability Services should register with that office as soon as possible. Even if you don't know whether you'll need to utilize the accommodations, it's in your best interest to prepare ahead of time and get your condition documented as accommodations are not retroactive. They have a quick and easy registration process. All you need is documentation for your condition.
- The Office of Disability Services also handles services for many temporary disabilities (for example, if you break your arm, they can arrange note taking services). Please contact them if you discover any sudden impairment that affects your ability to function in class and/or on your projects. They have a quick and easy registration process. All you need is documentation for your condition.

**Student Support Resources on Campus:**

<https://stearnscenter.gmu.edu/knowledgecenter/knowning-mason-students/student-support-resources-on-campus>