

# CS 475 Fall 2019 – Concurrent & Distributed Systems

## “Concurrent & Distributed Systems”

Fall 2019: Mondays & Wednesdays, 9:00am-10:15am, Exploratory L003



Instructor: Prof. Jonathan Bell

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Office: 4422 Engineering Building; (703) 993-6089

Office Hours: Anytime electronically via Piazza, TBD in person, or by appointment

### Contacting:

Please post on Piazza for course-related inquiries.

### Pre-Requisites:

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 Java to be able to do the programming assignments (note: this semester, all assignments will be in Java). It is also not a good idea to take this class if your course/work schedule is already quite full.

### Objectives:

The class focusses on issues that arise in the design and implementation of concurrent and distributed applications. Course work will involve several programming assignments.

### Learning Outcomes:

- Demonstrate an ability to design and implement concurrent programs
- Demonstrate an understanding of the fundamental concepts in synchronizing concurrent processes and threads by using locks, semaphores and monitors
- Demonstrate an ability to design and implement distributed programs using current middleware technologies
- Demonstrate an understanding of the fundamental concepts underlying distributed programming including message passing and remote procedure calls

## Readings:

### Please note change in book from prior years:

Required textbook: "The Art of Multiprocessor Programming", Revised Reprint, 1st Edition (Herlihy and Shavit) <https://www.amazon.com/Art-Multiprocessor-Programming-Revised-Reprint/dp/0123973376/> (Also at the bookstore)

Recommended additional textbook (E-book): Distributed Systems 3rd Edition (van Steen and Tanenbaum) <https://www.distributed-systems.net/index.php/books/distributed-systems-3rd-edition-2017/>

## Grading:

There will be five programming assignments. The software required for these projects is available on the computers in the IT&E Lab. You can also do the projects on your own computer. (The programming assignments involve programming in Java on a UNIX/Linux platform.) You must do the programming assignments individually.

40% Programming Assignments

15% Final Project

10% Quizzes and in-class activities

15% Midterm Exam

20% Final Exam

## Homework policy

Students must work individually on all homework 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. You are free to reuse small snippets of example code found on the Internet (e.g. via StackOverflow) provided that it is attributed. If you are concerned that by reusing and attributing that copied code it may appear that you didn't complete the assignment yourself, then please raise a discussion with the instructor.

10% will be deducted for late HW assignments and late HW assignments will only be accepted for 24 hours after the due date. **HW assignments submitted more than 24 hours 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. **Homework that does not compile or run will receive at most 50% credit.**

**For fairness to all, there are no exceptions to the above rules.**

### In Class Activities:

Most lectures will feature interactive activities and/or quizzes that support the material being presented. These quizzes and activities are meant primarily to help me understand how well you (and the class as a whole) are understanding the material that day. These quizzes will be graded on a "did it" or "didn't" basis: you either take the quiz, and you get the marks, or you did not take the quiz, and do not get the marks (that is, as long as you answer the questions, you get full credit, regardless of what the answers are). You must be present in class to take the quiz (participating in an online quiz remotely will be considered an honor code violation). You can miss up to three quizzes with no penalty.

You are strongly encouraged to bring your laptop or phone to class so that you can participate in the activities.

### Schedule (subject to change):

#	Date	Topic	Notes	Slides
1	8/26/19	Class Overview; Introduction to Concurrency	Reading: H&S 1.1-1.2	
2	8/28/19	Processes & Threads	Reading: H&S 1.5 HW1 out	
3	9/4/19	Mutual Exclusion	Reading: H&S 2.1-2.3	
4	9/9/19	Concurrency and Correctness	Reading: H&S 3.1-3.7	
5	9/11/19	Concurrency in Java	Reading: H&S 3.8, 8.1-8.5	
6	9/16/19	Locking Strategies: Coarse, fine	Reading: H&S 9.1-9.5 HW1 Due	
		Locking Strategies:	Reading: H&S 9.6-9.9	

7	9/18/19	Optimistic	HW2 out
8	9/23/19	Locking Strategies: Lazy	
9	9/25/19	Spin Locks and Contention	Reading: H&S 7.1-7.4
10	9/30/19	Barriers	
11	10/2/19	Concurrent Programming Models	Reading: H&S 16.1-16.2
12	10/7/19	Network Fundamentals	Additional Reading: Saltzer <a href="#">Ch 7.1,7.2</a> HW2 Due; HW3 out
13	10/9/19	Midterm	
14	10/15/19	Midterm Review; RPC/RMI	Midterm solutions on Piazza
15	10/16/19	RPC/RMI	Additional Reading: Tannenbaum 4.2
		Transactions Agreement	Reading: Tannenbaum 8.5

Jon Bell

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19	10/30/19	Consistency (Relaxed)	Reading: Tannenbaum 7.2-7.3.
20	11/4/19	Naming & DNS	
21	11/6/19	Distributed Filesystems	Reading: <a href="#">OS-TEP Ch 49</a>
22	11/11/19	GFS & MapReduce	HW4 due; Project Out <a href="#">Bonus: Podcast about how DropBox works</a>
23	11/13/19	ZooKeeper & Curator	Prof Bell traveling, YouTube lecture ZooKeeper code example: <a href="#">Explained (YouTube)</a> , <a href="#">Empty</a> , <a href="#">Finished</a> Additional info: <a href="#">Podcast about ZooKeeper at PagerDuty</a> , <a href="#">Blogpost testing ZooKeeper's guarantees and comparing to Etcd/Consul</a>
24	11/18/19	Sharding & CDNs	
25	11/20/19	P2P	

26	11/25/19	Byzantine Fault Tolerance	
27	12/2/19	Security	Course evaluation in class
28	12/4/19	Review	
	12/16/19	Final Exam from 7:30am – 10:15am	

## Honor Code:

GMU is an Honor Code university; please see the [Office for Academic Integrity](#) for a full description of the code and the honor committee process, and the Computer Science Department's [Honor Code Policies](#) regarding programming assignments. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

## Course Policy on Electronic Devices:

Please feel free to use laptops, tablets, etc. to take notes, review slides, etc. during class. I make only one request: If you know that you will need to be doing *other* things on your screen/device too (answering emails, purchasing concert tickets the moment they go on sale, perusing facebook etc), please sit in the back row, to ensure that *other students* are not distracted by your screen. We all need to do this stuff some times, and I have no judgements on you if you choose to sit in back with your screen open — just do not distract those sitting around you.

## Accommodations for Disabilities:

If you have a documented learning disability or other condition that may affect academic performance you should: 1) make sure this documentation is on file with Office for Disability Services (SUB I, Rm. 4205; 993-2474; <http://ods.gmu.edu>) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs.

## Privacy:

Students must use their MasonLIVE email account to receive important University information, including messages related to this class. See <http://masonlive.gmu.edu> for more information.

## Notice of Mandatory Reporting of Sexual Assault, Interpersonal Violence, and Stalking:

As a faculty member, I am designated as a "Responsible Employee," and must 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 one of Mason's confidential resources, such as Student Support and Advocacy Center (SSAC) at 703-380-1434 or Counseling and Psychological Services (CAPS) at 703-993-2380. You may also seek assistance from Mason's Title IX Coordinator by calling 703-993-8730, or emailing [titleix@gmu.edu](mailto:titleix@gmu.edu).

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## Contact

