CMSC 442
Operating Systems
Fall 2025
http://marmorstein.org/~robert/Fall2025/cs442.html

Lecture (Stevens 118): 9:30am – 10:45am TR

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Office Hours: 12:00 – 3:00pm TR *or by appointment*

To make an appointment, please contact me by Slack or by e-mail with your schedule for the week. Include as much detail as you can about why you need to see me (this saves time). I will reply with some times I am available within the next two days so that we can find a time that works for both of us.

Course Description: A programming-intensive course in which students learn the important data structures and algorithms of an operating system and apply them to the implementation of core O.S. components. Particular focus will be given to problems that arise in the presence of concurrency in both implementation of the operating system and application of programming. Topics include threads, synchronization constructs, I/O and interrupt handling, memory management, addressing, scheduling, and file system design. **3 credits.**

Prerequisites:
CMSC 201 and CMSC 242.

Textbooks: This course uses two textbooks:
1. The Little Book of Semaphores, by Allen B. Downey, Version 2.1.5, available as a free PDF at http://www.greenteapress.com/semaphores/   (The "LBoS")

2. Operating System Concepts, by Abraham Silberschatz, Peter Galvin, and Greg Gagne, Wiley Books, 10th edition, ISBN: 978-1-119-29967-7.   (The "Dinosaur Book")

Course Student Learning Outcomes: By the end of the course, the successful student will be able to:
– make use of semaphores and other primitives to synchronize concurrent processes/threads.

– describe common algorithms and data structures for scheduling, memory management, and file system organization.

– explain how the design of an operating system impacts user-space applications.

Course Requirements:

This class will have both a strong programming and a strong homework component. The projects will comprise 40% of your grade. Homework and quizzes will comprise another 35%. The midterm and final exams will be worth 10% each. The remaining 5% of your grade will consist of a participation grade.

Course Structure and Student Expectations:

This is a project-driven course with a significant theory/homework component. In addition to time spent in class, you should expect to spend a **minimum of 6 hours** a week on reading, homework assignments, and projects. The workload will vary – some weeks you will have less work, while other weeks you will have more.

Projects: The projects in this class are hard – probably much harder than anything else you've done in the major – and require a significant investment of time and effort. You will be required to work in groups and your grade will reflect both the quality of your group's submission and your individual contribution within your group.

You should set aside plenty of time for the projects and plan ahead for group meetings and deadlines. Groups will consist of three students (with some groups of two if necessary). I will allow you to choose your own groups, but if you do not select a group by the time I hand out the first project, I will assign you to a group.

Choose your group carefully, as the projects are cumulative and **you will not be able to switch groups between projects.** I will NOT play referee in your groups, so be sure to pick people you can work with all semester.

Homework Problems and Quizzes: In addition to the projects, I will assign weekly readings from the textbooks. Due dates for the readings are listed in the tentative schedule (see below). I will expect you to know the material from the textbooks well enough to apply it to homework assignments and quizzes. Some of these will be unannounced "pop" quizzes, but homework assignments will typically be assigned every two to three weeks.

Tests: There will be two exams in this course. A midterm and a cumulative final exam. The questions on the exams will largely be taken from the theoretical material covered in lectures, homework assignments, and readings, but may also include some material related to the semester projects.

Slip Days: Your group will be allocated a fixed number of slip days at the start of the semester which you may use to extend the due date of one or more *programming labs*. You may use all of your group's slip days on as many or as few projects as you like. Keep in mind, however, that once you use them up, they are gone for good.

Slip days are calculated from the minute the assignment is due until you turn it in and are rounded *up* to the nearest integer value of days. That means that if you turn an assignment in 24 hours and 1 minute late, you will use up *two* slip days. The slip day clock runs over weekends and holidays, so if a lab is due on Friday and you turn it in on Monday, you will have used three slip days, not just one. Slip days cannot be exchanged, traded, bought, or sold.

University Policies: This course adheres to the university policies found at http://www.longwood.edu/academicaffairs/syllabus-statements/.

Disability Accommodations Policy: If have a disability and require accommodations for this course, I am happy to work with you, but you must (prior to receiving accommodations) do two things:

1. Register with with the Accessibility Resources Office in Brock Hall

2. Schedule a meeting with me early in the semester to discuss a plan for your accommodations.

Should you need temporary accommodations due to an injury or illness, you should reach out to both me and ARO and we can discuss how to meet your needs while you work with ARO to address your long-term needs.

Grading Policy: Your final grade in this course is computed using a weighted average of your scores on each assignment. The weights for each category are given in the course requirements section of this syllabus and can be used by applying the following formula:

Final Grade = 0.40 * Projects + 0.35 * (Homework and Quizzes) + 0.05 * Participation + 0.10 * Midterm + 0.10 * Final

Each of the category grades (such as Projects) can be computed by summing the points you've earned on each assignment in that category and dividing by the total number of points possible. Numeric grades are translated to letter grades using the following grading scale:

	100-91:	A	90:	A-
89: B+	88-81:	B	80:	B-
79: C+	78-71:	C	70:	C-
69: D+	68-64:	D		
63 or lower: F				

There is no grade of D- in this course. Any grade below 64% is a failing grade.

Late Work: In general, I do not accept late work or grant extensions on assignments unless you have a serious medical or family emergency which prevents you from completing the assignment on time (however, see "Slip days" below). In such cases, you do not need a doctor's note, but you must notify me of the circumstances within a reasonable amount of time.

Since slip days do not apply to homework or quizzes, I may occasionally be persuaded to grant extensions on these assignments. However, in cases where I grant such extensions, I will impose a penalty of 25% per day overdue.

All requests for extensions (whether for an emergency or not), MUST be submitted **by e-mail** within a reasonable amount of time (typically twelve hours from the original due date). This e-mail should outline (in detail) the reasons your work is late. Granting of extensions is entirely at my discretion – if you have not turned an assignment in on time, you should expect to earn a 0%.

Slip Days: Your group will be allocated a fixed number of slip days at the start of the semester. You may use your slip days to extend the due date of one or more *programming projects.* You can use all of your slip days on one assignment or you may use them over multiple assignments. Slip days are per-group, not per-indivdual.

Slip days are calculated from the minute the assignment is due until you turn it in. The number of slip days used is rounded *up* to the nearest integer value. That means that if you turn an assignment in 24 hours and 1 minute after the due date, you will use up *two* slip days. The slip day clock runs over weekends and holidays. If a lab is due on Friday and you turn it in on Monday, you will have used three slip days, not one. Slip days cannot be shared, traded, bought, or sold, but can occasionally be earned by participation in relevant campus activities I select. In such cases, any member of the group can attend to earn the slip day.

Attendance: I expect you to attend class unless you are sick or engaged in a school-sponsored sport or extracurricular activity. Please do NOT come to class if you are sick. Instead, contact me within 12 hours of the absence to check whether you've missed any work and make arrangements to make up any missed quizzes. You should also make arrangements to get notes from another student in the class.   You should also check the course web site for announcements, new assignments, and other important updates.

I will rely primarily on your honor for enforcement of the attendance policy. However, I will keep a record of your attendance. In accordance with Longwood policy, missing more than 10% of scheduled class time (5 class sessions) to unexcused absences may, at my discretion, result in loss of one letter grade and missing 25% of class or more (14 sessions), whether excused or not may result in an automatic failing grade.

Cell Phones and Laptops: Cell phones, music players, and laptops are to be turned off and put away during class, except as needed for the lab sessions. Violations of this policy will be considered an **unexcused** absence. I will not interrupt class to notify you if you have been counted absent for use of a prohibited device. Feel free to contact me by e-mail at any point in the semester to check on the number of absences you have in my class.

Food and Drink: You may bring non-alcoholic beverages, including soft drinks, to class. However, please do not eat in class (it distracts me and the other students). Violations of this policy will be considered an **unexcused** absence. I will not interrupt class to notify you if you have been counted absent for violation of this policy. Feel free to contact me by e-mail at any point in the semester to check on the number of absences you have in my class.

I occasionally grant exceptions to this rule for students who must otherwise forgo lunch or have medical needs that require them to eat in class. If you feel that you need such an exception, you must make arrangements with me in advance (i.e. before bringing food to class).

Honor Code and Collaboration: I believe very strongly in the honor code. As such, I encourage you to actively collaborate with other students and to discuss homework problems. However, there is a point at which collaboration becomes cheating. To help you understand the line between acceptable discussion of a project and dishonorable behavior, I ask you to observe the following rules:

1. **Exams and quizzes are to be completed entirely on your own.**

   You may not discuss them with anyone or use any resources except those specifically outlined on the handout.

2. **You must give proper attribution.**

   Whenever you receive help or use an online resource, you should comment your code to give proper credit. The best way to do this is to place a comment above or on the same line as the code on which you received help or used a resource. For example:

   /* based on http://codewarrior.com */

   or

   /* Jessica helped me with the curly braces here */

   is fine. You DO NOT need to cite material you obtain directly from me (in lecture, the assignment handout, or office hours). In general, you also DO NOT need to cite material taken from the textbook.

3. **The work you submit should, in general, be either your own original work or material which I have provided and you have suitably modified yourself.**

You MAY use web sites, books, and the man pages as reference materials. However, you must cite them appropriately and **you MUST re-type any code** you find online and not just download it or copy/paste it.

At no point should another student touch your keyboard while helping you with a project.

For homework and projects, everything you turn in should be something YOU have personally typed or hand-written. **You may NOT copy code electronically from other students or the Internet.**

You MAY NOT share code with other students using flash drives, cell phones, e-mail, web sites, Slack, Discord, CDs, floppy disks, or other means unless I specifically direct you to do so. You MAY NOT print out copies of your code to share with other students (**personal copies or copies to show me during office hours are fine**).

4. **Do not copy large blocks of code from other students or the Internet.**

You MAY assist other students or get assistance with simple problems like syntax errors, but you MAY NOT copy large blocks of code, such as entire classes or functions, from anyone else. This includes both other students and external sources, such as web sites. How much code is "too much" depends partly on context, but a good guideline of what "large" means is that copying more than three complete programming statements is usually too much.

There are web sites that purport to have solutions or "walkthroughs" for some of the projects in this course. **You MAY NOT use these sites in any way.** (This includes not only code repositories, but also online videos and web forums).

5. **You may not use Generative AI on your assignments.**

Generative AI technologies (including large language models, such as ChatGPT, Google Bard/Duo/Gemini, Meta's Llama, and Github Co-pilot) use sources without proper attribution. As such, use of these tools implicitly commits plagiarism, an honor code violation. You MAY NOT use these tools in any way on work you submit for this course.

You MAY use these tools to generate examples for your own learning and study as long as none of the code or other content you generate is used (even accidentally) on any submitted work.

6. **You are responsible for securing your code.**

Helping other students to cheat is also cheating. Furthermore, it is your responsibility to make sure that other students do not use your work to cheat. Be careful with who you let access your account and report any missing files, flash drives, or other devices to me promptly.

Infractions of these policies will be dealt with harshly under the Longwood Honor Code. **Any student convicted of an honor offense involving this class will automatically receive a final course grade of F** in addition to any penalties imposed by the Honor Board. You should consider all work in this class to be pledged work, whether or not the pledge appears on the assignment.

If you have questions about the honor code policy, PLEASE ask me. It is much better to receive a late penalty on a single assignment than to fail the course and face honor board charges. If you are stuck on an assignment, I am happy to help you in a way that encourages learning and retention.

You may find the scenarios at https://integrity.mit.edu/handbook/writing-code helpful in understanding this policy. While their honor code policy is not identical to mine, it is similar.

Communications Policy: The best way to get in touch with me is to use **Slack**. Slack is a chat utility with clients for mobile devices and desktop computers. I recommend you install it on both types of devices. Slack will allow you to easily send me code snippets, ask questions in real time, or set up a Zoom meeting (or Google Hangout) if we need to video chat. You should sign up for a Slack account by visiting https://longwood-cmsc.slack.com. Use your @live.longwood.edu email address to register and you will be automatically approved.

Slack is also a good way to communicate with other members of the class. You will be invited to a public **#cmsc-442** channel in which you can discuss the projects and other course topics with other students in the class. Feel free to ask for help on this channel, but please stick to general questions rather than posting code.

I will expect you to check the **#cmsc-442** channel every day before class in case I have posted an announcement or asked you to bring something to class.

When you send me a Slack message, I instantly get a notification on my computer, tablet, and phone. Typically, I will reply to Slack messages within 24 hours (often sooner) on weekdays.

While I am often available in the evening or on weekends, you may need to be patient if I am busy with other students or family obligations.

You can also reach out to me by e-mail to marmorsteinrm@longwood.edu. However, please do not send me large files by e-mail. They take up space toward my limited quota on the mail server and cause me all sorts of headaches. **E-mail messages containing large files will be deleted unread.**

I am much slower at replying to e-mail (since I do not get a notification and have to log in to check it). Typically, you can expect a reply to an e-mail within 48 hours, but this may be longer on weekends, and I may not receive your message at all or may not be able to respond to it (my inbox is often over the "quota" allowed by campus I. T. and this often prevents me from using the system effectively).

If you are **asking for help with a project or homework problem**, you should attach your work to a direct message in Slack so that I can see where you are at. You should do this by using the "plus" icon to attach the file directly to your message or by copy/pasting the particular snippet of code you are working on to the body of the message.

Please do NOT attach pictures of your code taken on your phone. These are blurry and hard to read and I can't run them to see why they are failing. If you need me to see your screen, you can take screenshots of your Unix system using the "spectacle" program (usually by pressing the Print Screen "PrtSc" key).

One last suggestion: don't "ask to ask". I am delighted to answer questions about the projects and homework assignments and you should feel free to ask questions at any time (yes, even 3am the night before the project is due – I MIGHT be awake and online). Asking me whether you can ask a question wastes my time and yours.

Tentative Course Schedule:

Week1 (Aug. 26 – 28)   Introduction: Hardware, Interrupts, and System Calls

Read Chapter 1 and Sections 2.1 – 2.6 of the Dinosaur Book (p. 3 – 51 and 55 – 79: **74 pages**)

Homework 1 (Due: Sept. 2nd)

Week 2 (Sept. 2 – 4)   Processes and Threads, The Process Control Block (PCB), Scheduling, Amdahl's Law

Read Sections 3.1 – 3.6 and Sections 4.1 – 4.3) of the Dinosaur Book (p. 105 – 132 and p. 159 – 168: **38 pages**)

Homework 2 (Due: Sept. 9th)

Sept. 2   Last Day to Drop (by 5pm)

Week 3 (Sept. 9 – 11)   Synchronization, Semaphores, Signaling, Rendezvouses, Mutual Exclusion, Multiplexing, Deadlocks, and Barriers
Read LBoS Chapters 1 – 3 (54 pages)

Week 4 (Sept. 16 – 18)   The Producer/Consumer Problem, Readers and Writers, The Dining Philosophers
Read LBoS Chapter 4 (60 pages)

Homework 3 (Due: Sept. 23rd)

Week 5 (Sept. 23 – 25)   Non-classical Semaphore Problems
Read LBoS Chapter 5 (50 pages)

Project 2: Interrupts, Scheduling, and Synchronization (PintOS)
(Due Sept. 25th)

Sept. 25   **Symposium Day: NO CLASS**
(for students in CTZN 410; Project Work Day for the rest of us)

Week 6 (Sept. 30 – Oct. 2)Scheduling Algorithms, Multi-processor Scheduling
Read Sections 5.1 – 5.6 of the Dinosaur Book (p. 199 – 234: 36 pages)

Midterm Review (Due: Sept. 30)

Week 7 (Oct. 7)   Midterm Exam

Oct. 9   FALL BREAK: NO CLASS

Week 8 (Oct. 14 – 16)   **Memory Management: Fixed and Dynamic Partitioning,
Pages and Segments, Page Tables**

Read Sections 9.1 – 9.6 of the Dinosaur Book (p. 349 – 382: 34 pages)

Homework 4 (Due: Oct. 21st)

Week 9 (Oct. 21 – 23)   **Virtual Memory, Logical and Physical Addresses, The TLB,
Swapping, Page Faults and Thrashing**
Read Sections 10.1 – 10.9 of the Dinosaur Book (p. 390 – 440: 51 pages)

Project 3: System Calls and Process Memory (PintOS)
(Due: Oct. 23)

Week 10 (Oct. 28 – 30)   **Mass Storage Devices**
Read Chapter 11 of the Dinosaur Book (p. 449 – 484: 36 pages)

Homework 5 (Due: Nov. 4th)

Week 11 (Nov. 4 – 6)   **Project Work Week**

Project 4: Virtual Memory (Due: Nov. 6th)

Nov. 5   **DEADLINE TO WITHDRAW WITHOUT AN F (by 5pm)**

Week 12 (Nov. 11 -- 13)   **Files, Directories, and File Systems**

Read Chapter 14 of the Dinosaur Book (p. 529 – 593: **65 pages**)

Week 13 (Nov. 18 – 20)	Modern File Systems

Read Sections 15.1 – 15.7, 20.7 – 20.8, and 21.5 of the Dinosaur Book (p. 597 – 609, 803 – 812, and 875 – 879: **28 pages**)

Project 5: File Systems (Due: Nov. 20)

Week 14 (Nov. 25)	**Catchup and Review**

Final Review (Due: Dec. 2)

Nov. 26 - 28	NO CLASS: THANKSGIVING BREAK
Week 15 (Dec. 2 –4)	**Catchup and Review**
Dec. 11	**Final Exam** (Thursday, 8:00am – 10:30pm)