CMSC 442: Operating Systems (Fall 2022)
http://marmorstein.org/~robert/Fall2022/cs442.html

Instructor: Robert Marmorstein, 395-2185, marmorsteinrm@longwood.edu
Office Hours (Stevens 109): Tue/Thr 9:20am – 11:00am, Wed 11:00 – 11:50am and 3:00 – 4:30pm

I am also available by appointment. To schedule an office visit, contact me on Slack at least 24 hours in advance.

Lecture (Stevens 118): 12:00pm – 12:50pm MWF

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.

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.

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/

2. Operating Systems: Internals and Design Principles, by William Stallings, Prentice Hall, Ninth Edition, ISBN: 978-0-13-467095-9.

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. I will expect you to know the material from the textbooks well enough to apply it to homework assignments and quizzes. Some of these may 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 midterm will be taken in class, while the final exam will be completed remotely and submitted electronically. The questions on the exam 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.

Honor Code:

I take the honor code very seriously. I encourage you to take advantage of the freedom it gives you to collaborate with other students and to use print and Internet resources to better understand the material.

Because it is possible to abuse these resources in a way that actually hinders you from learning or disadvantages other students, I have established some guidelines for their use that you MUST follow.

Please read these rules carefully. It is your responsibility to know them and follow them.

Exams and quizzes are to be completed entirely on your own. Exams will be closed book/closed notes tests on which you may receive no external help and may use no resources other than your brain and a writing instrument (unless explicitly stated in class).

On homework assignments and projects, you may discuss your work with other students subject to these restrictions:

1. Turn in only your own work

The work you submit should, in general, be your own original work or material which I have provided and you have suitably modified. You **MAY** discuss problems with others in a general way. You **MAY** assist other students (or get assistance) with simple problems like syntax errors, but you **MAY NOT** copy solutions or large blocks of code from each other. You **MAY** use web sites, books, and other resources as references, but you should not use large blocks of code from these sites, either.

The definition of "large" in this case varies somewhat based on context, but a good guideline is that while copying one to three lines of code is usually okay, copying a complete function, class, or file is usually too much.

The purpose of this rule is to ensure that you understand the code or answers you are submitting. If you don't think you could explain your work to me without help or looking at a book or web page, you probably should not submit it.

2. Give proper attribution

If you **DO** get help or use an online resource to complete a project, you **MUST** give credit to your source. Taking credit for someone else's work is a form of intellectual theft called plagiarism. To cite a source for homework assignments, you can simply add a note in the margin next to the answer on which you received help. In projects, you should comments to your code. A simple comment like

```
/* Based on http://codewarrior.com */
```

or

```
// Susan helped me with this step
```

is fine.

The comment should go **directly above the line or lines on which you received help** to make it clear which parts of your program are original and which are derived from other sources, NOT at the top of the file or in a separate document.

You do not need to cite help you have received directly from me or from the textbook.

3. Do not copy code electronically

Any work you turn in should be work which YOU have typed or hand-written unless I have explicitly instructed you to download or copy/paste it. Typing in blocks of code helps you retain what you have learned better and acts as a safeguard for rule two.

You **MAY NOT** share code with other students using flash drives, cell phones, e-mail, web sites, floppies, CDs, or any other electronic storage or communication device unless you are both assigned to the same group for a project. You **MAY NOT** print out copies of your code to share with other students (personal copies or copies to bring to office hours are fine as long as you don't leave them lying around the lab). You **MAY** copy or download any code I have posted to Slack or the course web site for your use.

4. 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 computer 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.

Attendance:

This class is heavily lecture-driven and will require your regular attendance. Unless you are unable to come to class for health reasons (or an official school sponsored event), I will expect you to attend in person.

In accordance with Longwood policy, missing more than 10% of scheduled class time will result in loss of one letter grade. Students who miss more than 25% of classes, whether excused or not, may at my discretion receive an F for the course.

Absences for school events, illness, or other exceptional circumstances may be excused if you contact me by e-mail prior to or within 12 hours of the missed class. To seek such an accommodation, your e-mail should explain the reason for your absence in sufficient detail that I can determine whether the absence should be excused.

In the event you are sick, it is your responsibility to make up any missed work and get notes over the missing content.

In general, I will not stream lectures for students who miss for illness. However, if you may need to miss class for an extended period of time (such as for COVID quarantine), I may be able to adapt lectures to a format suitable for streaming. To request this accommodation, send me documentation of a legitimate health problem at least 48 hours in advance.

Grading Policy:

Late work will not be accepted unless you have a medical condition or serious emergency which prevents you from completing the assignment on time. In such circumstances, you do not need a doctor's note, but you must contact me by e-mail before the assignment is due (or within 12 hours of the deadline) to explain the circumstances and arrange to make up the work. Such exceptions are granted very rarely. Technical problems involving the use of the submit system, your computer, or lab resources are not valid reasons to submit work late (that is what slip days are for).

Final letter grades will use the following scale:

	A: 91 – 100%	A-: 90%
B+: 89%	B: 81 – 88%	B-: 80%
C+: 79%	C: 71 – 78%	C-: 70%
D+: 69%	D: 64 – 68%	F: 0 – 63%

(Note: there is no grade of D- in this course)

Mental Health, Disabilities, and Sexual Assault:

I follow Longwood's campus policies on Mental Health, Disability Accommodation, and Mandatory Reporting of Sexual Assault and Other Crimes, Please see http://www.longwood.edu/academicaffairs/syllabus-statements/ for the complete policy.

Face Coverings and Intellectual Property:

Please also see http://www.longwood.edu/academicaffairs/syllabus-statements/ for the university policies on wearing masks to class and a statement on intellectual property. Both of these policies apply to this class.

Cell Phones and Laptops:

Cell phones, music players, and laptops must be turned off and put away during lecture and class discussions unless I have specifically requested that you use them. Violations of this policy will be considered an unexcused absence and may also affect your homework or participation grades.

Food and Drink:

Please do not eat in class (it distracts me and the other students). You may bring water or other non-alcoholic beverages to class. I occasionally make exceptions to this rule for students who would otherwise miss 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 before you bring food to class (preferably by e-mail). Violations of this policy will be considered an unexcused absence and may also affect your homework or participation grades.

Tentative Course Schedule:

Week1 (Aug. 22 – 26)	Introduction, Hardware, Interrupts and System Calls **Read Stallings Chapters 1 – 2**
Aug. 29	**Last Day to Drop (by 5pm)**
Week 2 (Aug. 29 – Sept. 2)	Processes and Threads, The Process Control Block (PCB), Process Management **Read Stallings Chapters 3 – 4** **Project 1: Introduction to Synchronization**
Week 3 (Sept. 5 – 9)	Synchronization, Signaling, Rendezvouses **Read Downey Chapters 1 – 2** **Recommended: Read Stallings Chapter 5**
Week 4 (Sept. 12 – 16)	**Mutual Exclusion, Multiplexing, Barriers, Deadlocks, and the Dining Philosophers** **The Producer/Consumer Problem** **Read Downey Chapters 3 – 4** **Recommended: Read Stallings Chapter 6**
Week 5 (Sept. 19 – 23)	**Readers/Writers, Non-classical Semaphore Problems** **Read Downey Chapter 5** **Project 2: Interrupts, Scheduling, and Synchronization**
Week 6 (Sept. 26 – 30)	**Memory Management: Fixed and Dynamic Partitioning,** **Pages and Segments, Page Tables** **Read Stallings Chapter 7**
Week 7 (Oct. 3 – 5)	**Catch up and Review, Midterm Exam**
Oct. 7	**FALL BREAK: NO CLASS**
Week 8 (Oct. 10 – 14)	**Virtual Memory, Logical and Physical Addresses, The TLB,** **Swapping, Page Faults and Thrashing** **Read Stallings Chapter 8** **Project 3: System Calls and Process Memory**
Week 9 (Oct. 17 – 21)	**Advanced Memory Management** (Page Replacement, Demand Paging, Prefetching, Write-back and Write-through)
Week 10 (Oct. 24 – 28)	**Scheduling Algorithms, Multi-processor Scheduling** **Read Stallings Chapters 9 and 10**
Nov. 2	**DEADLINE TO WITHDRAW WITHOUT AN F (Wednesday, 5pm)**
Week 11 (Oct. 31 – Nov. 4)	**Project Work Week** **Project 4: Virtual Memory**
Week 12 (Nov. 7 – 11)	**Files and File Systems, Directories** **Read Stallings Chapter 11**

Week 13 (Nov. 14 – 18)	Modern File Systems **Read Stallings Chapter 12** **Project 5: File Systems**
Week 14 (Nov. 21)	**Catchup and Review**
Nov. 23 - 25	**NO CLASS: THANKSGIVING BREAK**
Week 15 (Nov. 28 - Dec. 2)	**Catchup and Review**
Dec. 7	**Final Exam (Wednesday, 3:00pm – 5:30pm)**