CMSC 442: Operating Systems (Fall 2020)

http://marmorstein.org/~robert/Fall2020/cs442.html

Lecture: 12:05pm - 12:55pm MWF (Stevens 118)
Instructor: Robert Marmorstein, 395-2185, marmorsteinrm@longwood.edu
Office Hours: 2:00pm - 2:50pm MTWRF, Online (or by appointment in Ruffner 329)

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.

Course Student Learning Outcomes : By the end of the course, the successful student will be able to:

– Make use of semaphores, monitors, and locks to synchronize concurrent processes and threads.

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

– Explain how the design of an operating system impacts design and performance of user-space applications.

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.

Most of the homework assignments will consist of problems from these two books.

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 some 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.

Attendance: This class is heavily lecture-driven and will require your regular attendance. I expect you to attend class unless you are sick or engaged in a school sponsored sports event or extra-curricular activity. In accordance with Longwood policy, missing more than 10% of scheduled class time will result in loss of one letter grade. Absences for school events, illness, or exceptional circumstances may be excused if you make arrangements with me within 12 hours of the missed class. Students who miss more than 25% of classes, for any reason, may – at my discretion – receive an F for the course.

Grading Policy: ***Late work will not be accepted*** unless you have a medical condition or family 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 at least 12 hours before the assignment is due to explain the circumstances and arrange to make up the work. Such exceptions are granted very rarely. Of course, you may also apply slip days to extend your projects, if you have them. You do not need to contact me in order to use slip days. 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 be based on 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)

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.

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. They will be closed book/closed notes exams 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 and lab 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.

On projects, a good guideline of what "large" means is that copying one or two lines of code is usually okay, but copying a complete function or more than three complete statements 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. Do not copy code electronically

Any work you turn in should be work which YOU have typed or hand-written.

This doesn't mean you can't look online for help with a project. It does mean that you must re-type any code you find and not download it or copy/paste it.

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).

Feel free to discuss projects and homework using the markerboard – just be sure that when you are done you erase your work before you leave the room. Do NOT take pictures of such code on your phone.

3. Give proper attribution

Whenever you use any kind of resource (including other people), you should give credit to your source. On homework assignments, simply add a note in the margin next to the answer on which you received help. In code, you should add comments to give proper credit. 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. You do not need to cite help you have received directly from me or from the textbook.

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.

Tentative Course Schedule:

Week1 (Aug. 24 – 28)	Introduction, Hardware, Interrupts and System Calls **Read Stallings Chapters 1 – 2**
Aug. 28	***Last Day to Drop (by 5pm)***
Week 2 (Aug. 31 – Sept. 4)	Processes and Threads, The Process Control Block (PCB), Process Management **Read Stallings Chapters 3 – 4** **Project 1: Synchronization**
Week 3 (Sept. 7 – 11)	Synchronization, Signaling, Rendezvouses **Read Downey Chapters 1 – 2** **Optional: Read Stallings Chapter 5**
Week 4 (Sept. 14 – 18)	Mutual Exclusion, Multiplexing, Barriers, Deadlocks, and the Dining Philosophers The Produce/Consumer Problem **Read Downey Chapters 3 – 4** **Optional: Read Stallings Chapter 6**
Week 5 (Sept. 21 – 25)	Readers/Writers, Non-classical Semaphore Problems **Read Downey Chapter 5** **Project 2: NachOS Synchronization**
Week 6 (Sept. 28 – Oct. 2)	Catch up and Review, **Midterm Exam**
Week 7 (Oct. 5 – 9)	Memory Management: Fixed and Dynamic Partitioning, Pages and Segments, Page Tables **Read Stallings Chapter 7**
Week 8 (Oct. 12 – 16)	Virtual Memory, Logical and Physical Addresses, The TLB, Swapping, Page Faults and Thrashing **Read Stallings Chapter 8** **Project 3: NachOS System Calls and Process Memory**
Week 9 (Oct. 19 – 23)	Replacement Algorithms, Demand Paging, Prefetching, Write-back and Write-through
Week 10 (Oct. 26 – 30)	Scheduling Algorithms, Multi-processor Scheduling **Read Stallings Chapters 9 and 10**
Week 11 (Nov. 2 – 6)	Project Work Week **Project 4: NachOS Virtual Memory**
Week 12 (Nov. 9 – 13)	Files and File Systems, Directories **Read Stallings Chapter 11**
Week 13 (Nov. 16 – 20)	Modern File Systems **Read Stallings Chapter 12** **Project 5: Filesystems**
Nov. 23 - 25	**Thanksgiving Break**
Week 15 (Nov. 24 - Dec. 1)	Catchup and Review
Dec. 8	**Final Exam (Friday, 11:30am – 2:00pm)**