Syllabus
CMSC 242: Introduction to network and systems programming

Spring 2023

Time:	MWF 1pm
Room:	Stevens 118
Websites:	`https://canvas.longwood.edu/courses/1307911` `https://www.cs.longwood.edu/courses/cmsc242`

Introduction to network and systems programming. A programming-intensive class covering the fundamentals of operating systems and networking. Emphasizes the use of programming using an Application Programming Interface (API). Topics covered include threading and parallelism, low-level filesystem access and memory management, communication using signals, socket programming, and the TCP/IP network stack. Prerequisite: CMSC 162. 3 credits.

Professor:	Don Blaheta
Office:	Rotunda 334
Phone:	x2191
Email:	`blahetadp@longwood.edu`
100% Office hours:	Mondays 3–4pm; Wednesdays 10–11am; Thursdays 1:30–3pm; Fridays 2–3pm

Overview

In this class, we study principles and implementations of operating systems and networking. The operating system manages hardware resources and provides a simplified interface for programs to use these resources. Networking allows different computers to communicate and potentially act as a larger virtual system. These topics are closely related; networking is often managed by the operating system (and always requires use of the hardware it manages) and the operating system uses the network to provide services like the file system. To facilitate our study of these topics, we will write programs in the C language, which provides low-level access to the hardware and is often used in operating systems and networking.

Textbook and resources

The book for this class is *OpenCSF: Computer Systems Fundamentals* by the OpenCSF project. It is free and online.[1]

The other main resource is provided by us: you'll be given an account on the department Linux machines (if you don't already have one), and you'll do your programming work there.

I'll ask you to join the Slack channel for this course. It's a good venue for the same kinds of questions and discussions you might have in class, and counts towards participation and engagement.

You will be expected to have a computer that can connect to the internet and various reference websites, and run PuTTY or another ssh client to connect to the department Linux machines.

In the hopefully unlikely event that you need to go into quarantine or isolation (for Covid-19 or for some other reason), but are otherwise well enough to continue working, I'll expect that you have a device (your computer, or a phone or tablet) that is capable of connecting to a live meeting via Zoom, and reasonable bandwidth to accommodate that.

In the hopefully even more unlikely event that the campus returns to a classroom mask mandate, you will be expected to have (and wear) a mask or the equivalent.

Covid-19 notes

This section is happily much-abridged from the version I wrote for the last few years, but as the pandemic isn't quite over yet, some attention to Covid-19 is still relevant.

Attending class. There are two ways you can attend class: in person, or via Zoom link. Either mode of attendance is sufficient for purposes of evaluating your presence and participation; if you attend via Zoom link,

- you must have a reason, and
- you must say what it is,

but I don't need any medical detail and if it's not directly covid-related I'm not going to police that. (Basically: be an adult and make good choices.) The

[1] `https://w3.cs.jmu.edu/kirkpams/OpenCSF`

Zoom experience is nowhere near equivalent to the in-person experience and is not a replacement for it; but if you are quarantined, or otherwise just can't attend in person on a particular day, zooming is better than total absence.

Important note: I plan to, in general, turn on Zoom every day; but it's possible I won't if I don't know for sure someone will be attending that way. Try to fill out the "why am I zooming today" link as soon as you know you'll need to.

Zooming vs masking. As we work out how to emerge from the pandemic, I'd just like to remind everyone that masking is still a tool in our toolkit. If you have had a Covid-19 exposure, or have just emerged from isolation, or even just feel a bit sniffly today and "it's probably just allergies", you're not required to zoom (and, as noted, we do prefer in-person attendance where possible) but I do encourage you to wear a mask. We all have masks, we all got really good at wearing them, and it's a courtesy to your classmates to take this easy step to decrease the likelihood of spreading anything. (Including colds and other stuff! Masks help us not spread *lots* of things.)

Of course, if the university returns to a classroom mask mandate, then we'll all wear masks in the classroom per the updated policy.

What if the professor gets sick? Same as for students: if I'm feeling a little sniffly, I'll wear a mask, and if I am more seriously sick (but well enough to teach), I'll zoom myself into the class. If necessary I can teach from a zoom window on the projector screen (and have done so!); I'll send an email with instructions as soon as I know I need to do this.

Learning outcomes

At the end of this course, the successful student will be able to:

1. use the Linux command line and system tools to effectively develop software,

2. create programs which use system calls and library functions to control functionality of the operating system and network stack,

3. implement algorithms using parallel and multi-threaded programming, and

4. write client and server applications that communicate using TCP/IP sockets.

Graded work

I figure that I have on average about 9 hours of your time every week, including class time as well as reading, practice, homework, and projects. If you find you're regularly spending substantially more time than this, please do come discuss it with me, so that we can ensure you're making the most effective use of your time. The work you do for this course will be evaluated as follows:

Engagement. You need to be actively engaged in this class. Engagement comes in many forms, but I expect that you will be interacting with your classmates, and with me, both in class (in-person or Zoom) and in the Slack channel. General engagement will be evaluated in two-week blocks—so you don't need to artificially say a thing every day—and it's ok if most of your engagement is via Slack as long as *some* of it is in class (spoken or in the Zoom chat). In addition, there may be occasional required specific interactions via Canvas or Slack that will be considered part of the engagement grade, and when I (occasionally) do reading quizzes they'll be part of this too.

Labs and Projects. I draw a distinction between a "lab" (roughly a week's worth of work) and a "project" (multiple weeks, typically with intermediate goals and some design component), but both comprise work that is chiefly programming and are grouped together here for grading purposes. (Projects will be worth roughly three times as much as labs.) In both cases, you can talk amongst yourselves as long as you aren't writing each other's code; see the collaboration policy.

Homework. For some of the conceptual stuff that is not really assessed via the project work, there will be a few homework assignments. These will be due after a few days, but you will have a chance to revise it; it's also group work, so you can hand in a single copy for the whole group.

Exam. There will be one exam, a final, at the end of the semester. It will be take-home, and you will be given several days to work on it. It will be non-collaborative: **You are not permitted to discuss the exam, *at all,* with anyone other than me.**

Breakdown

Labs and projects	60%
Homework	15%
Exam	20%
Engagement	5%

Grading scale

I tend to grade hard on individual assignments, but compensate for this in the final grades. The grading scale will be approximately as follows:

A−	[85, 90)	A	[90, 95)	A+	[95, 100]
B−	[70, 75)	B	[75, 80)	B+	[80, 85)
C−	[55, 60)	C	[60, 65)	C+	[65, 70)
D−	[40, 45)	D	[45, 50)	D+	[50, 55)

While there will be no “curve” in the statistical sense, I may slightly adjust the scale at the end of the term if it turns out some of the assignments were too difficult. Final grades of A+ are recorded as an A in the grading system. Final grades below the minimum for D− are recorded as an F.

Note that *individual* grades recorded in Canvas should be accurate (and you should let me know if there’s a data entry error!), but *averages* as computed by Canvas sometimes are not, if the averaging is complex or (especially) if an individual student has a special case scenario. The reference gradebook is my own spreadsheet, and while I will try to make Canvas reflect it (including averages) as well as I can, Canvas can’t always handle it.

Schedule

Labs and homeworks will will go out intermittently and typically be due 2–3 class days later. The larger assignments (exams and projects) are tentatively scheduled as follows:

	Out	**Due**
Project 1	6 Feb	1 Mar
Project 2	3 Mar	3 Apr
Project 3	5 Apr	28 Apr
Final exam	28 Apr	4 May

If any of those dates need to change, I will give advance notice.

Topics

Wk	M	W	F
	January		
1		**11** — Introductions; C vs C++; printf, scanf	**13** §§10.3–10.5 Pointer basics; C strings and other arrays; Functions, pointers as out params **Lab 1 out**
2	MLK Day **no class**	**18** — More work with C	* **20** §10.6, Ch 1 Heap allocation in C; Models and semantics; System architectures **Lab 1 due** **Lab 2 out**
3	**23** §2.1 Memory and the kernel	**25** §§2.2–2.5 Files and directories in C (high-level); Kernel and system calls; Processes	**27** — `fork` **Lab 2 due** **Lab 3 out**
		February	
4	**30** §§10.8, 2.7 C function pointers; Events and signal handling	**1** §§3.1–3.2 Direct file I/O; File descriptors, stdin, stdout;	**3** — Overview of IPC
5	**6** §3.3 Pipes and FIFO **Lab 3 due** **Proj 1 out**	**8** §3.4 Processes and pointers Memory-mapped files	**10** — mmap, cont’d
6	**13** §§3.5–3.6 POSIX vs System V; Message passing **Proj 1 prep**	**15** — Project design work **Proj 1 design** **Hwk 1 out**	**17** §3.7 Design, cont’d Shared memory
7	**20** — Shared memory, cont’d **Hwk 1 due**	**22** — C stack/heap allocation review	**24** ** §§3.8, 4.1–4.3, 4.4 (exc 4.4.4) Semaphores, take 1; Networking fundamentals, TCP/IP socket programming

* **19 January**: Deadline to add/drop classes (5pm)

** **17 February**: Deadline to elect pass/fail option (5pm)

Wk	M	W	F
	February	**March**	
8	**27** §§4.3, 4.5 Sockets, cont'd; Application layer protocols	**1** §§4.5–4.6, 5.3 (exc 5.3.1) HTTP, DNS Transport layer **Proj 1 due**	**3** §§4.4.4, 5.3.1, 5.5 Internet layer (IP); Datagrams and UDP **Proj 2 out**
		SPRING BREAK	
9	**13** — NAT vs IPv6 **Proj 2 prep**	**15** — TBA **Hwk 2 out**	[Prof absent **no class**]
10	**20** Project design work **Proj 2 design**	**22** §§5.4 (esp 5.4.4–5), 5.6, 5.7 Design cont'd Transport layer security Lower networking layers **Hwk 2 due**	**24** §§6.1–6.4 Intro to threads Threads demo
11	**27** — Threads with arguments	**29** * §6.5 Returning values from threads	**31** §6.6 Threads in other languages
	April		
12	**3** §§7.1–7.2 The problem of synchronisation **Proj 2 due**	**5** — Synchro cont'd; Peterson's solution **Proj 3 out**	**7** §§7.3, 7.4 Synchro with locks; Semaphores, take 2
13	**10** — Other synchro abstractions; Deadlock **Proj 3 prep**	**12** — Classic sync problems **Hwk 3 out**	**14** — Project design work **Proj 3 design**
14	**17** — Design cont'd **Hwk 3 due**	[Research Day **no class**]	**21** — Thread sync design patterns
15	**24** — TBA	**26** — TBA	**28** — TBA **Proj 3 due** **Exam out**
	May		

Exam due: Thu 4th, 10:30am

* **29 March** : Deadline to withdraw from a class (5pm)

Policies

You can find several university-wide course policies at
`http://www.longwood.edu/academicaffairs/syllabus-statements/` .

"Office hours"

If I'm in my office and my door is open, that means I'm available for you to drop in and ask questions, and I'm happy to turn on my "office hours" zoom link so you can join me that way instead. At least four hours a week I've designated as 100% hours, i.e. there's a nearly 100% chance I'm available at those times.

But I'm in my office a lot and I'd like to effectively communicate to you when you're most likely to catch me, so if you look at my office schedule on my website or linked from Canvas, you'll also see many hours listed with other percentages like 60% or 40 or 10, as informal estimates of the probability I'll have office hours in that block for drop-in questions. (If you want more certainty, you can always give me advance notice and be extra sure I'll be there at whatever time!)

If you can't catch me in my office, email or Slack is probably your best bet.

Honor code policy

Above all, I ask and expect that you will conduct yourself with honesty and integrity—and not to ignore the other ten points of the Honor Code, either. Take pride in what you are capable of, and have the humility to give credit where it is due.

The two main forms of academic dishonesty are "cheating" and "plagiarism". "Cheating" is getting help from someplace you shouldn't, and "plagiarism" is presenting someone else's idea as if it's your own. If you ever find yourself inclined towards either of these, know that there are always other, better options. Persevere! See my website[2] for some discussion and examples of how to steer clear of these problems, and feel free to come talk to me if you need help finding some of those other options (even if it's for another course).

Cheating or plagiarism (on any assignment) will normally receive a *minimum* penalty of lowering the *course* grade by a full letter, and may range at my

[2] `http://www.cs.longwood.edu/~dblaheta/collab.html`

discretion up to an F *in the course.* Cases will also be turned in to the Honor Board. But: I believe in your potential, and I hope that you will, or will grow to, observe this policy not simply to evade punishment but positively as a matter of character.

Accommodations

If you have any special need that I can accommodate, I'm happy to do so; come speak to me early in the term so we can set things up. If you have a documented disability, you should also contact Longwood's Accessibility Resources Office (Brock Hall, x2391) to discuss some of the support the college can offer you. All such conversations are confidential.

Attendance and late policy

Attendance is required, and assignments must be turned in on time. That said, if you have a good reason to miss class or hand something in late, I tend to be fairly liberal with extensions if you ask in advance. (Good reasons do include assignments due for other classes.) (And medical and family emergencies are exempted from the "in advance" part, of course. But contact me ASAP.)

Frequent absence will result in a lowered participation grade; habitual absence may in extreme cases result in a failing grade for the class. *Unexcused* late assignments will normally be given a zero.

Inclement weather policy

I don't plan to cancel class for weather unless the entire college shuts down; and if the campus closes, I'm likely to hold class in some form by zoom instead (check your email). If you are commuting or are otherwise significantly affected by a weather event, use your own best judgement (and remember that zoom is an option); and if you do miss class for this reason (e.g.: power's out too), contact me as soon as possible to make up missed work.

Early bird policy

Nobody's perfect, and on occasion an assignment gets written a little unclearly (or, once in a while, with an actual error in it). If you catch one and bring it to my attention early, so that I can issue a clarification or correction to the rest of the class, there'll be some extra credit in it for you.