ECE 252: Systems Programming and Concurrency (Spring 2019)

Department of Electrical & Computer Engineering
University of Waterloo

About the Course

Undergraduate Calendar Description "Processes and threads (pthreads); system calls; concurrency (semaphore, mutex, monitors, and barrier synchronization); user-level memory management. Performance and correctness of concurrent systems. Deadlock detection and recovery; file systems."

Prerequisites ECE 250 (Algorithms and Data Structures).
We will take some time to go over some of the important things you need to know about the C programming language (especially given you are most likely to have used C++ for your data structures and algorithms course). Still, this course assumes you have an adequate programming background. If you are not feeling confident in your programming skills, I recommend you take some time at the start of the term to get caught up. There are some excellent C instructional websites & videos out there (or ask for a recommendation about some good ones).

Course Website As is standard, key information and announcements relevant to the current term will be posted on Learn. For the notes and slides, please refer to Github: `https://github.com/jzarnett/ece252` to be sure that you have the latest information.

Textbook W. Richard Stevens and Stephen A. Rago: *Advanced Programming in the UNIX Environment*, 3^{rd} edition, Addison-Wesley, 2013. ISBN: 978-0-321-63773-4.

Also useful to have: Michael Kerrisk: *The Linux Programming Interface*, No Starch Press, 2010. ISBN: 978-1-59327-220-3.

Do you need a textbook? You decide how much use you can get out of it. There will not be homework assignments that refer to it, but you can still get good use of it.

ILOs. At the end of the course, students will be able to:

- Invoke (apply) system calls, from the view of an application programmer, to access resources like files, inter-process communication mechanisms, and the network.
- Analyze, design, implement, and debug concurrent C programs, using concurrency control constructs (such as a mutex or semaphore).
- Apply standard concurrency scenarios such as producer-consumer, readers-writers, dining philosophers, as well as deadlock and starvation.

At the end of the labs, students will be able to:

- Interact with the Linux operating system through the command-line interface and the C language API.
- Read the documentation of, understand, and interact with available libraries such as those for threading, files, and network operations.
- Use inter-process communication such as shared memory and message queues.
- Identify, analyze, and solve concurrency and synchronization problems.

Class Schedule

Check your schedule of classes for where and when your labs and lectures are; no need to reproduce it here.

Midterm Week: Classes are not held during the midterm week.

University Holidays: 20 May (Victoria Day), 1 July (Canada Day), 5 August (Civic Holiday)

Schedule Oddities: A Monday schedule will be followed on 2 July; a Tuesday schedule will be followed on 30 July.

Partially-Flipped Classroom: During the term we will do four in-class exercises. For this you'll need to be physically present and bring a laptop. I'll announce them at least a week in advance. How they work is, during a particular lecture period, we will have a designated amount of time in which to complete a programming exercise. It's not a test: you are allowed to use google, talk with your neighbours, and ask for help from the course staff. The goal is to practice and reinforce some skill(s) covered in the preceding lectures.

The in-class exercises are graded in a binary fashion: 1 if you made a reasonable attempt; 0 if you did not. Your feedback may be asked following the in-class exercise. I thank you in advance for any input you have, whether you like or hate the idea and/or execution.

Make-Up Lecture Dates: Assume we will use all of the make up lecture slots. You will be told in advance if we will NOT use one of the other make up lectures. They are also in your schedule of classes.

Lab Dates: Please see your schedule of classes for when the labs will take place. There are five lab sessions.

Final Exam: The final exam dates are 2 August - 16 August. On or about 29 May, the registrar's office will announce the exact date, time, and location of the exam. It could be at any time in this period. Note that student travel plans are *not* considered an acceptable reason for missing an exam. When it is announced, please alert the ECE Department immediately if you have a conflict.

Course Staff

For all course staff, office hours are by appointment. Please keep in mind that course staff have other responsibilities, so it may not be possible for them to meet with you at the last minute. Similarly, please do not expect that course staff will answer an e-mail sent seven minutes before the final exam.

Instructor	Jeff Zarnett	`jzarnett@uwaterloo.ca`
Lab Instructor	Irene Huang	`yqhuang@uwaterloo.ca`
TA	Huanyi Chen	`h365chen@uwaterloo.ca`
TA	Tejinder Singh	`t42singh@uwaterloo.ca`

About Prof. Zarnett. I graduated from the Computer Engineering program at Waterloo (under the previous curriculum), and have since earned my Master's Degree (also at Waterloo) and my P.Eng. license. For the last 6+ years I have also been teaching here at UW and the other courses I have taught and worked on include ECE 150, ECE 155, ECE 254, ECE 290, ECE 356, ECE 459, and MTE 241. So, software. Lots of software. And then law and ethics. One of these things is not like the others...

In addition to being your instructor, I work full time in software engineering in industry. The vast majority of the week, I will not be on campus, so camping outside my office is a very inefficient way to find me. The best way to get in touch with me is e-mail. I'm more than happy to answer questions by e-mail, and if they can't be answered that way, we can set up an appointment for office hours.

About the Lab Instructor. The lab instructor can answer your questions about the labs in this course. You may contact the lab instructor to arrange some more time with the lab equipment, if you need. The lab instructor will be present at the labs and will supervise them.

About the Teaching Assistants. Teaching assistants can help you with the course material, including tutorials, labs, and exams. They will be present in the labs and will conduct the tutorials. TAs will also hold office hours, or you may make an appointment with them..

Grading Scheme

Your class grade is the weighted average of your marks in the labs l, the midterm exam m, and the final exam f. The grading scheme as described in the syllabus is a contract between the instructor and the students. After the start of the term, it cannot be changed, except by 100% approval of all students in the class (and that means every student must vote yes, not just an absence of objections).

The midterm has a weight W_m of 21. If you do not take the midterm exam for any valid reason (e.g., verification of illness form submitted), the grading scheme will change such that the final exam absorbs the weight of the midterm. If you write the midterm, it will count – there is no option where the weight is shifted to the final if your final exam grade is better.

The in-class exercises have a weight W_e of 4 (that is, each is worth 1% of the overall grade). If you do not attend the in-class exercise any valid reason (e.g., verification of illness form submitted, or co-op interview with documentation from CECA), the grading scheme will change such that the final exam absorbs the weight of the exercise.

The weight of the labs W_l depends on your final exam grade f and follows this formula:

$$W_l = \begin{cases} 25 & \text{if } f \geq 60 \\ f - 35 & \text{if } 40 \leq f < 60 \\ 5 & \text{if } f < 40 \end{cases}$$

The weight of the final is W_f is $100 - (W_l + W_m + W_e)$.

Your final grade is calculated as: $\frac{W_e}{100}e + \frac{W_l}{100}l + \frac{W_m}{100}m + \frac{W_f}{100}f$.

A grade of INC (Incomplete) is to be assigned if you do not make a reasonable attempt all lab studies. If the lab studies are not completed within 4 months of the end of the course to the satisfaction of the course instructor, the INC (Incomplete) grade will be converted to FTC (Failure to Complete). If the lab studies are completed successfully within the required timeframe, the overall grade will be calculated using the rules for late assignment submission.

The University rules say if you miss the final exam, without an acceptable reason, your grade in the class will be DNW - Did Not Write. This is very undesirable. Show up for the final exam.

See also the section about late submissions under the section Course Policies.

I cannot tell you about your final exam grade or your total course grade until after marks become visible in Quest. Please do not e-mail me (or any of the TAs, or the Lab Instructor) after the final exam asking about your grades.

Labs

The lab descriptions, policies, and procedures are clearly explained in the lab manual. Please read it carefully; it is the definitive source of information about the labs.

Your lab code will be checked for plagiarism using Moss (Measure Of Software Similarity). You may request to opt out of the automatic screening by sending a formal written letter to your instructor explaining why; a meeting will then follow to discuss the subject with the instructor.

Course Policies

Collaboration & Plagiarism Plagiarism, taking credit for work that others did, is not permitted, and this applies to source code as well as exams. The course staff will be checking for it through a variety of different methods. Any cases of plagiarism I detect will be reported, according to university policy (see the University Policy section below).

In the (hopefully unlikely) event of any student(s) discovered in an incident of academic dishonesty, I will report this to the Associate Dean of Undergraduate studies. Should the Associate Dean conclude that plagiarism or another academic integrity violation has occurred, the punishment applied will be as the Associate Dean directs. Most likely, every student involved will receive a grade of 0 (zero) for the corresponding evaluation item, and additionally will receive a deduction of 5 (five) marks from the final grade of the course as a standard penalty. However, penalties may be more severe for repeat offenders (see below for information on Academic Integrity). In cases where the incident consists of submitting common work (such as labs which are done with your lab partner(s)), every student involved will be subject to the above penalty — no student will be allowed to "take full responsibility", regardless of who copied and who is the genuine author of the work submitted; and regardless of the actions by the students involved or related events that led to the incident. The rule is unconditional.

All of the above applies to multiple instances — a student caught in several incidents of academic dishonesty will be subject to the above penalties *for each of the incidents*.

It is expected you will collaborate with your lab partners. Your lab submissions are joint efforts and the work you submit in is that of your lab group. Note, however, that grades are still individual and if one group member is not contributing to the lab work at all, that student may receive a zero in the lab.

You may discuss ideas, design alternatives, and help other groups debug small fragments of code. However, each group must submit their own, independently-developed code for each lab. I suggest you avoid looking at other groups' code entirely, but if you do, then you should not be doing that anywhere you might be writing your own code. The temptation to write your code just like what you see is simply too high.

Groups are not permitted to share code electronically or in written form, unless such sharing has been clearly documented and acknowledged in the receiving work. An acknowledged fragment will not be considered while grading the lab, but will not result in disciplinary penalties. Acknowledgements must include the name of the providing group and the date of the collaboration. It is very important to acknowledge the work of others if you use it.

For the record, all members of a group take responsibility for a submitted piece of work. Thus, if a member of your lab group copies some code from another group and it is submitted under all of your names, even if you did not know that some code was copied, you will both be held responsible. Accordingly, if you copy some code, your lab partner(s) will jointly be held responsible for your actions. Please don't plagiarize.

I want to emphasize that I take the issue of plagiarism very seriously, and so does the University of Waterloo. If you are uncertain about this subject, please seek some guidance. There are many resources available to you. You can check the university policies, talk to the course instructor or lab instructor, visit the ECE Undergrad Office, et cetera.

Or, let's sum this up in two short instructions:

1. Acknowledge the work of others.
2. If you are uncertain, ask!

Re-marking If you believe that your grade on the midterm is incorrect, you may ask that it be re-marked. To request that a question be re-marked, you will need to submit your request on a sheet of paper, in writing, to me (the instructor). You may submit it to me in person, or ask an administrative assistant at the Electrical & Computer Engineering undergraduate office to put it in my mailbox. Please do not hang around outside my office hoping to find me (this is really inefficient). Please do not submit it to a TA or lab staff.

When you submit your request, it should include the following: (1) Your name and student ID number; (2) a clear indication of which question or part of the deliverable is to be re-marked; and (3) an explanation of why you believe the grade assigned was incorrect.

Staple your request (not paperclip, not some sort of origami) to the midterm exam so they do not get separated.

I will accept items for re-marking any time before the final exam, including as I'm arriving to the room where the final exam is to be written (I have actually done this myself as a student). Be forewarned, when a deliverable is being re-marked, your grade could go up, it could stay the same, or it could go down. I will notify you of the outcome and attempt to return the deliverable you submitted (if any).

Extra Credit In this class, there will be no opportunities to earn extra credit. Make-up assignments, labs, or examinations will not be offered under any circumstances.

Attendance & Illness My personal opinion on attending classes is that it is usually a good idea to attend lectures. That said, this is university and you are capable of deciding for yourself if you are going to the lecture or not. Attendance is not taken and not graded. No attendance is taken in tutorials or labs, but at least one member of your lab group will need to be present in the labs to present lab deliverables.

Some advice from Professor Gebotys when I was in 2A: If you are tired, go sleep at home. Sleeping in the lecture doesn't work; you will get poor quality of sleep and you won't learn the material while you're asleep, either.

During the term, you may need arrive late to a class or leave partway through, because of co-op interviews. This is not a problem, as long as you are not disruptive when arriving/departing.

If you feel ill, you should seek appropriate medical attention. If you miss an exam or other deliverable for health reasons, you need a verification of illness form. Forms can be completed by the physicians at Health Services. If you anticipate missing a deliverable deadline or an examination for a non-medical reason, you should contact me as soon as you are aware of the problem. Given sufficient notice, alternate arrangements may be possible. Alternate arrangements are rare and at instructor discretion.

Laptop and Device Policy The human visual system has evolved to perceive saber-toothed tigers. Fortunately, tigers are rare in Waterloo, Ontario (Geese, on the other hand...). Unfortunately, your classmates are still human and hence their attention will be drawn to flashing lights (or Facebook, or movies, or video games) in their peripheral vision. We'd like to encourage everyone to be respectful of their classmates and to not distract them.

Wise use of computers and the Internet can be helpful for fully engaging in class. You might want to try out some syntax, or you might want to look up some pthread syntax, or you might want to verify your instructor's somewhat outrageous-sounding claim.

To support the benefits of the Internet while reducing distractions, we will adopt the following policy in this class. I am asking that the first 2 rows of class be text-oriented: if using a device, use a command prompt or text editor, maximized to the whole screen. Paper is always good, of course. Mac OS X and UNIX command prompts are probably your best bet; for those of you on Windows, you can use the Windows Subsystem for Linux. From the command prompt, you can use compilers and text-mode web browsers (w3m, lynx, links/elinks, etc....) tmux may also be helpful in managing multiple terminal sessions. Being proficient with the terminal is a highly-useful skill.

I acknowledge that lectures are not always engaging. Instead of distracting screen content, I recommend non-distracting ways of tuning out, like doodling on paper (while taking notes), or doing homework. (I also recommend passing notes to each other instead of talking).

Enforcement is a sensitive issue, especially given the existence of exceptions. We are primarily asking each of you to respect the policy on your own. But, if you see someone with games, videos, or social media in the terminal zone, you can politely bring it up with them.

The summary on this is: if you want to use your laptop, you can, but please, don't do potentially-distracting things in the first two rows, where your screen may be distracting to those sitting farther back.

University Policies

Intellectual Property Students should be aware that this course contains the intellectual property of their instructor, TAs, and/or the University of Waterloo. Intellectual property includes items such as:

- Lecture content, spoken and written (and any audio/video recording thereof);
- Lecture handouts, presentations, and other materials prepared for the course (e.g., PowerPoint slides);
- Questions or solution sets from various types of assessments (e.g., assignments, quizzes, tests, final exams); and
- Work protected by copyright (e.g., any work authored by the instructor or TAs or used by the instructor or TAs with permission of the copyright owner).

Course materials and the intellectual property contained therein, are used to enhance a student's educational experience. However, sharing this intellectual property without the intellectual property owner's permission is a violation of intellectual property rights. For this reason, it is necessary to ask the instructor, TAs, and/or the University of Waterloo for permission before uploading and sharing the intellectual property of others online (e.g., to an online repository). Permission from an instructor, TAs, or the University of Waterloo is also necessary before sharing the intellectual property of others from completed courses with students taking the same/similar courses in subsequent terms/years. Doing so without expressed permission is considered a violation of intellectual property rights. Please alert the instructor if you become aware of intellectual property belonging to others (past or present) circulating, either through the student body or online. The intellectual property rights owner deserves to know.

Academic Integrity In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. Check `www.uwaterloo.ca/academicintegrity/` for more information.

Grievance A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, `adm.uwaterloo.ca/infosec/Policies/policy70.htm`
If in doubt, contact the department's administrative assistant, who will provide further assistance.

Discipline A student is expected to know what constitutes academic integrity (see above section) to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, `www.adm.uwaterloo.ca/infosec/Policies/policy71.htm` . For typical penalties check Guidelines for the Assessment of Penalties, see
`www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm` .

Appeals A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals)
`www.adm.uwaterloo.ca/infosec/Policies/policy72.htm`.

Privacy Questions about the collection, use, and disclosure of personal information by the University, should be directed to the Freedom of Information and Privacy Coordinator, Secretariat, University of Waterloo, 200 University Avenue West, Waterloo, Ontario, Canada N2L 3G1. The email address of the Freedom of Information and Privacy Coordinator is `fippa@uwaterloo.ca`. See also University of Waterloo Policy 19: Access to and Release of Student Information; Information and Privacy.
`https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-19`

Note for Students with Special Needs The AccessAbility Services (formerly known as OPD) located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the AccessAbility Services office at the beginning of each academic term.