CST 334 - Operating Systems

Tu/Th 10-12, Gambord 110

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Prerequisite: CST 238 or equivalent

Course Description
A computer's operating system provides convenient features for users and application developers. A power user must know not only how to use these features, but also how the operating system provides them. In this course, students will learn about the use and design of modern operating systems, with a focus on Linux. On the "use" side, students will learn to navigate the Linux file system, to write shell scripts, and to combine commands with pipes. Students will also learn to build programs using important GNU utilities such as awk, sed, and make. On the "design" side, students will become familiar with core OS design problems, such as how to run multiple applications at once. Students will also learn how OS principles apply to virtualization.

Course Outcomes
At the end of class, you will be able to:
   ● explain core OS design problems and alternative solutions to each problem
   ● use the bash shell and Linux utilities like awk, sed, and make
   ● write bash shell scripts
   ● write C code that makes Linux/GNU system calls
   ● write correct concurrent programs in C
   ● define language syntax in BNF and write recursive descent parsers

Class Format
Normally, we'll have a lecture of about 25 minutes, a lab of about 20 minutes, a break, and then we'll have another short lecture and lab. With this format we'll avoid long lectures and let you test your understanding right after the lecture. Always bring your laptop and a pencil and paper to class.

Teaching and Learning
I believe it's more important that you ask questions, think, and get interested in the subject than achieve all course learning outcomes. Operating Systems is a "systems" course and you will see that the ideas we talk about in class apply to all kinds of systems, not just computers.

Class schedule

Below is the planned weekly schedule. Textbook chapters are shown in parentheses. If it makes sense, I will make adjustments based on class needs and progress. The latest version of the weekly schedule can be found on our iLearn page.

week	date	hour 1	hour 2	notes
1	1/21/2020	Course intro	OS intro (OS 2)	first day of class
1	1/23/2020	Linux setup	Linux and shell	
2	1/28/2020	C programming	computer architecture	
2	1/30/2020	bash: files and directories	bash: permissions	
3	2/4/2020	bash: how bash works	bash: pipes and redirection	
3	2/6/2020	processes (OS 4)	C process API (OS 5)	
4	2/11/2020	direct execution (OS 6)	process scheduling (OS 7)	
4	2/13/2020	multi-level feedback queue (OS 8)	exam prep	
5	2/18/2020	process mgt. exam	bash: regular expressions and grep	
5	2/20/2020	bash: awk	bash: sed and make	
6	2/25/2020	address spaces (OS 13)	C memory API (OS 14)	
6	2/27/2020	address translation (OS 15)	segmentation (OS 16)	
7	3/3/2020	free-space mgmt (OS 17)	paging (OS 18)	
7	3/5/2020	translation-lookaside buffers (OS 19)	advanced paging (OS 20)	
8	3/10/2020	swapping (OS 21,22)	exam prep	
8	3/12/2020	memory mgmt. exam	bash: scripts	
9	3/17/2020	threads (OS 26)	C threads API (OS 27)	
9	3/19/2020	locks (OS 28)	locked data structures (OS 29)	
10	3/24/2020	condition variables (OS 30)	Anderson/Dahlin method	
10	3/26/2020	semaphores	bash: variables	
11	3/31/2020	Spring Break		
11	4/2/2020			
12	4/7/2020	synchronization barrier, part 1	bash: string operations	
12	4/9/2020	synchronization barrier, part 2	exam prep	
13	4/14/2020	concurrency exam	Languages: syntax and parsing	
13	4/16/2020	Languages: lexical analysis	Languages: predictive parsing 1	
14	4/21/2020	Languages: predictive parsing 2	Languages: compilers and interpreters	
14	4/23/2020	Languages: review	I/O devices (OS 36)	
15	4/28/2020	hard disk drives (OS 37)	files and directories (OS 39)	
15	4/30/2020	file systems implementation - data (OS 40)	file systems implementation - access (OS 40)	
16	5/5/2020	special topic: virtualization	special topic: virtualization (or more prep)	
16	5/7/2020	final prep		
17	5/12/2020	Final		final during regular class time

Text

Arpaci-Dusseau and Arpaci-Dusseau, *Operating Systems: Three Easy Pieces*. The authors provide a free electronic version of the text

http://pages.cs.wisc.edu/~remzi/OSTEP/

You can also purchase a hard copy if you prefer.

Homework assignments

You'll be assigned homework weekly. It will usually be due on Tuesday. A homework assignment normally contains a reading assignment, some questions related to the reading, and a programming assignment. These weekly challenges are very important for your growth and learning.

The homework assignments will usually require about 8 hours of work. Do not try to do the homework in one or two sittings. The work will be much easier and you will learn more if you spread your work over at least 4 days. Start with the coding part of homework assignments first.

If you have problems with the homework, please ask the instructor or TA for help. You may also get help from fellow students, but you must follow the Stanford Honor Code: (follow link for details)

1. You must not look at solutions or program code that are not your own.
2. You must not share your solution code with others, and must maintain the privacy of your solution.
3. You must indicate on your submission any assistance your received.

A further quote from the Stanford honor code:

> *In computer science courses, it is usually appropriate to ask others--the section leaders, TAs, instructor, or other students--for hints and debugging help or to talk generally about problem-solving strategies and program structure. In fact, we strongly encourage you to seek such assistance when you need it. Discuss ideas together, but do the coding on your own.*

Be aware that I will use a plagiarism detector on submitted code.

Exams

Exams are done on paper, and I won't return them to you. However, we'll discuss the most-missed questions in class, and I encourage you to meet with me after an exam so that we can go over problems you missed in detail.

Class policies:

Sorry about the rules, but I'm dedicated to your learning and believe these policies will help optimize your learning and growth. Please read the following carefully to avoid misunderstandings.

- **attendance:** It's important that you attend class. I'll take attendance at the beginning of each class. If you're not present at that time you'll be marked as absent (in other words, late arrival = absent). You can miss two classes for any reason, but for every unexcused absence after the first two, 3 points (out of 100 total) will be deducted from your overall course score.
- **homework:** Late homework isn't accepted, but your single lowest homework grade will be dropped to account for any one-time issue you might have. Examples: you forgot to submit, you tried to submit but it was 10 seconds too late, your internet connection broke.
- **during lecture:** Please close your laptop and put your phones and tablets completely away. Research shows that note-taking is more effective with pen and paper than with laptop or tablet.
- **during lab:** I encourage you to work with a partner during lab. Please wait until the break to leave the room -- lab time is very important for your learning.

- **office meetings**: Please drop my office every so often. If you haven't had a class with me before (or had one but didn't pass), schedule a meeting with me during the first four weeks of class. If you don't, 5 points will be deducted from your overall course score. Use my Google calendar to schedule one or two 10-minute slots (see Google calendar link on our iLearn page).

Evaluation

I assess your performance on the following measures:

- **Homework**   (30% total).
- **Exams**   (48% total). Three 50-minutes exams during the semester.
- **Final**   (22% total).
- **Attendance**   Please see attendance policy above.
- **Bounty**   Bounty points for those who spot significant problems in course materials, or who go above and beyond in other ways. The rule about bounty is: if you ask if you will get points for it, you won't get points for it.

An overall course score will be calculated from the above measures, with a perfect score being 100 points. Your grade for the course will be computed from your overall course score as follows (where [90, 93) means a course score at least 90 but below 93):

A- [90, 93)	A [93, 97)	A+ [97, 100)
B- [80, 83)	B [83, 87)	B+ [87, 90)
	C [70, 77)	C+ [77, 80)
	D [60, 70)	
	F [0, 60)	

Communicating online

We will use email, iLearn and Slack for online class communication.

- email -- we'll use this for official communication between you and me
- iLearn -- we'll use this for course materials and posting/submitting assignments
- Slack -- I'll use this for announcements (instead of iLearn). Also, we'll use this for group discussion, and you can direct message me on Slack for help. I'll normally respond to Slack messages more quickly than email.

I'll expect you to check Slack and email at least daily for course communications.

Academic integrity

Any form of academic dishonesty will not be tolerated in this class. Academic integrity is of central importance to an education at CSUMB. The core of this integrity resides in the scholastic honesty of the CSUMB community, and therefore, is the responsibility of all students and faculty to uphold and maintain. Forms of academic dishonesty include: cheating, fabrication, plagiarism, and collusion in any of these activities. We value informal resolution of academic integrity allegations; however, students discovered to have engaged in academic dishonesty will be sanctioned.

For more information regarding the Academic Integrity Policy please go to:
https://csumb.edu/policy/academic-integrity-policy

Center for Student Success (CSS)
CSUMB works to make sure that all students are succeeding in their courses. If you are falling behind, please see me and our class TA, and I encourage you also to schedule an appointment with the Center for Student Success to create an Academic Success Plan and get back on track. The CSS offers services such as one-on-one support, peer mentoring, and study skills workshops. CSS is located in the Library, 3rd Floor, Suite 3180, 582-3165.

Collection of student work for assessment
CSUMB is committed to providing excellent and innovative curricula and educational opportunities to its students. To help us maintain quality academic offerings and to conform to institutional and professional accreditation requirements, the University and its programs regularly evaluate student work to assess student achievement of learning outcomes. CSUMB obtains, evaluates, and retains samples of student work from designated assignments in representative courses. This work includes, but is not limited to, papers, exams, creative works, recordings of oral presentations, or portfolios developed and submitted in courses or to satisfy the requirements for degree programs. Instructors will inform students which assignments will be designated for assessment purposes. Instructor and student names will not appear in any assessment results and assessment results will have no impact on student grades, instructor evaluations, or instructor employment.

Disability accommodation
Students with disabilities who require accommodations such as time extensions or alternate media/format must present current verification from Student Disability Resources as soon as possible. Please schedule an appointment to discuss specifics with me. If you think a disability may impact your performance in this class, meet with SDR professional staff in the Health and Wellness Services, Building #80. Contact SDR: (831) 582 - 3672 or Email: student_disability_resources@csumb.edu