

Operating Systems

CS 326 (4 units)

Spring 2023

Section 01 - TR 8:00am - 9:45am 01/23/23 - 05/11/23 HR 148

Section 02 - TR 2:40pm-4:25pm 01/23/23 - 05/11/23 HR 136

Section 01 Lab W 4:45pm-6:15pm LS 307

Section 02 Lab W 6:25pm-7:55pm LS 307

Instructor Information

Gregory Benson

benson@usfca.edu (Campuswire Preferred)

Office Hours

Tue/Thu 1:30pm-2:20pm, Wed 3:40pm-4:30pm

Office Location: HR 412A

Gaurav Kalele

gskalele@dons.usfca.edu (Campuswire Preferred)

Office Hours

Mon 7:00pm-9:00pm, Wed 1:30pm-2:30pm, Fri 11:00am-1:00pm

Office Location: HR 411/413

Shubham Pareek

spareek@dons.usfca.edu (Campuswire Preferred)

Office Hours

Mon 5:00pm-7:00pm, Tue 12:15pm-1:15pm, Fri 4:00pm-6:00pm

Office Location: HR 411/413

Course Description

The design and implementation of operating systems. Study of processes, threads, scheduling, synchronization, interprocess communication, device drivers, memory management, and file systems. Four hours lecture and two hour lab. Offered every Fall.

In this class you will learn about the design and implementation of operating systems. We will explore how an operating system kernel provides an abstraction of hardware resources and also manages resources such as processor time, memory, and disk space. We will study how a kernel implements the process model in which code can run in an isolated way so bad code cannot affect other processes or the kernel. You will learn how virtual memory is used to provide isolation as well as other operation system features. We will examine process scheduling and mechanisms for I/O handling. We will also investigate how a kernel can be extended to support containers.

Course Learning Outcomes

Upon completion of this course the students will have learned the following topics:

1. Write and test systems code in the C programming language including a shell
2. Extend an operating system kernel (xv6) with new system calls
3. Understand and modify the kernel process scheduler
4. Understand and modify the kernel memory allocator
5. Understand and extend the kernel virtual memory implementation
6. Evaluate and modify a kernel file system implementation
7. Extend the kernel to support containers

Assignments

1. Projects are the main assessment tool for the course. The project corresponding to each learning outcome is shown in parentheses above.
2. Projects will be graded for both correctness (using an automated tool) and comprehension (using 1:1 interactive grading meetings with the instructor or TA)
 1. If an interactive grading meeting is required for a project, you must attend the meeting to earn credit for the project.
3. Low-stakes labs will build into each project
4. There will be no exams

Grading Breakdown and Grading Policies

Grading Breakdown

1. Labs: 20%
2. Projects: 80%

Course Policies

1. Neatness counts, for both source code and circuit schematics
2. Original Work
 1. You may get explanatory help from the instructor, TAs, friends, tutors, or Internet sites
 2. You must turn in only original work that you personally developed and can explain
 3. You must not provide your original work to other students
 4. No credit will be given for work which violates this policy
3. Deadlines
 1. If you are not done with an assignment by the deadline, you should turn in what you have working to get full credit for that work
 2. Late work and corrections may be turned in for at least 50% credit, up to one week after grades are posted
 3. Extensions for full credit are not given except in extenuating circumstances, which you must discuss with the instructor in advance
4. Letter Grades are assigned according to the following table, without rounding or curving

Grade shown in Canvas	Letter Grade
100.0% - 93.33%	A
< 93.33% - 90.0%	A-
< 90.0% - 86.67%	B+
< 86.67% - 83.33%	B
< 83.33% - 80.0%	B-

Grade shown in Canvas	Letter Grade
< 80.0% - 76.67%	C+
< 76.67% - 73.33%	C (minimum grade for C)
< 73.33% - 70.0%	C-
< 70.0% - 66.67%	D+
< 66.67% - 63.33%	D
< 63.33% - 60.0%	D-
< 60.0%	F

Texts and Supplies

The C Programming Language

ISBN: 978-0131103627

Authors: Brian W. Kernighan and Dennis M. Ritchie

Publisher: Pearson

Publication Date: March 1988

Edition: 2nd

Where to purchase (URL): [https://www.amazon.com/Programming-Language-2nd-Brian-Kernighan/dp/0131103628/ref=sr_1_1?](https://www.amazon.com/Programming-Language-2nd-Brian-Kernighan/dp/0131103628/ref=sr_1_1?keywords=the+c+programming+language&qid=1674547425&srefix=The+C+programmin%2Caps%2C336&sr=8-1)

[keywords=the+c+programming+language&qid=1674547425&srefix=The+C+programmin%2Caps%2C336&sr=8-1](https://www.amazon.com/Programming-Language-2nd-Brian-Kernighan/dp/0131103628/ref=sr_1_1?keywords=the+c+programming+language&qid=1674547425&srefix=The+C+programmin%2Caps%2C336&sr=8-1)

Required or recommended?: Recommended

Course Schedule

Holidays

Spring Break 3/13 - 3/17

Program Learning Outcomes

Theory: explain and analyze standard computer science algorithms and describe and analyze theoretical aspects of various programming languages

Application: apply problem-solving skills to implement medium- and large- scale programs in a variety of programming languages

Systems: describe the interactions between low-level hardware, operating systems, and applications

Project: demonstrate effective communication and organization as part of a team of software developers or researchers collaborating on a large computer program

Attendance Policy

Attendance is strongly recommended but will not be formally recorded.

University Policies

Credit-hour Policy

One unit of credit in lecture, seminar, and discussion work approximates one hour of direct faculty instruction (or 50 minutes plus a break) and a minimum of two hours of out-of-class student work per week through one 15-week semester. For further details, see USF's [Credit Hour Policy](#).

Students with Disabilities

The University of San Francisco is committed to the full participation of all students. Student Disability Services (SDS) recognizes disability as a valued aspect of diversity and works to facilitate equal access and an inclusive environment for students with disabilities. The University offers many services to its students with disabilities. [Student Disability Services \(SDS\)](#) arranges these accommodations on an individual basis for each eligible student during the intake/eligibility process. You can initiate the [intake and eligibility](#) process through the office, or email or call SDS at sds@usfca.edu or (415) 422-2613. (All communication with SDS is private and confidential.) If you are determined eligible for accommodations, please request that your accommodation letter be sent to me as soon as possible; students are encouraged to contact SDS at the beginning of the semester, as accommodations are not retroactive. Once I have been notified by SDS of your

accommodations we can discuss your accommodations and ensure your access to this class or clinical setting. For more information please visit the SDS [website](#).

Behavioral Expectations

All students are expected to behave in accordance with the Student Conduct Code and other University policies (see the USF [Fogcutter](#)). Students whose behavior is disruptive or who fail to comply with the instructor may be dismissed from the class for the remainder of the class period and may need to meet with the instructor or Dean prior to returning to the next class period. If necessary, referrals may also be made to the [Student Conduct process](#) for violations of the [Student Conduct Code](#).

Academic Integrity

As a Jesuit institution committed to *cura personalis*—the care and education of the whole person—USF has an obligation to embody and foster the values of honesty and integrity. All members of the USF academic community are responsible for maintaining the standards of honesty and integrity.

The [honor code](#) applies to all students (undergraduate and graduate) in the College of Arts and Sciences, the School of Education, the School of Management, and the School of Nursing and Health Professions. Faculty and students in the School of Law should review their own honor code for policies and procedures. Students enrolled in distance learning (online courses) are subject to these policies as well as supplemental policies set forth by their program.

- Cheating

Cheating is the use or attempted use of unauthorized materials, information, and study aids, as well as unauthorized collaboration on examinations and other academic exercises. It is the responsibility of students to consult with their professors concerning what constitutes permissible collaboration. Cheating or helping others cheat is academic fraud.

- Plagiarism

Plagiarism is the act of presenting, as one's own, the ideas or writings of another; plagiarism, in any of its forms, violates academic integrity. While different academic disciplines have different norms of attribution, all strive to recognize and value individuals' contributions to the larger body of knowledge. It is the responsibility of students to consult with their professors in order to understand the norms of attribution in each discipline and area of study.

- False Citations

False citation is attribution to an incorrect or fabricated source; false citation is academic fraud. False citation seriously undermines the integrity of the academic enterprise.

- Submitting the Same Work for Multiple Assignments

Students may not submit work (in identical or similar form) for multiple assignments without the prior, explicit approval of all faculty to whom the work will be submitted. This includes work first produced at USF or at another institution attended by the student.

- Submitting False Data

False data is information that has been fabricated, altered, or contrived in such a way as to be misleading; the submission of false data is academic fraud.

- Falsifying Academic Documentation

Forging or altering academic documentation (including transcripts, signatures, letters of recommendation, certificates of enrollment or standing, registration forms, and medical certifications) concerning oneself or others is academic fraud.

- Abuse of Library Privileges

Depriving others of equal access to library materials constitutes a violation of academic integrity. This includes sequestering library materials for the use of an individual or group, refusal to respond to recall notices, and the removal or attempt to remove library materials from any university library without authorization.

- Abuse of Shared Electronic Media

Depriving others of equal access to shared electronic media used for academic purposes constitutes a violation of academic integrity. This includes actions that result in the damage or sabotage of campus computer systems.

Counseling and Psychological Services

Counseling and Psychological Services (CAPS) is a great source of support for issues of sadness, anxiety, loneliness, college adjustment, relationship struggles, and others not requiring medical intervention. CAPS offers online workshop series open to all students; consultations and referrals; and extensive [website resources](#). In addition, CAPS All Hours line can be contacted by calling (855) 531-0761 or students can use the peer-led Crisis Textline by texting HOME to 741741. CAPS also offers remote individual and group teletherapy to students residing within California. (State regulations prevent provision of therapy across state lines.) The student may choose to talk either by video or telephone and can engage in Single Session Therapy (SST), brief ongoing therapy, or group therapy. There are no fees for services. Please call (415) 422-6352 to make an appointment. Visit the CAPs [website](#) for more details. Students seeking off campus mental health services can also receive information and support from Case Management (part of the Office of the Dean of Students); visit the Dean of Students' [website](#) for further information.

Title IX

The Title IX Office seeks to stop, remedy, and prevent occurrences of sex and gender-based discrimination, sexual harassment, and sexual violence. The University has a [Policy on Nondiscrimination based on Sex and Gender, Sexual Harassment and Sexual Misconduct](#). If you have experienced any of these behaviors, we encourage you to report the incident. If you report these behaviors to any staff or faculty member, they must notify the USF Title IX Coordinator.

Students who wish to report any sexual misconduct should use the [online mandatory reporting](#) form, or contact the Title IX Office directly. Other reporting options are available by visiting the Title IX website: <https://myusf.usfca.edu/title-ix/reporting>. The Title IX Office is located in Lone Mountain Room 145.

As an employee at USF, and your Professor, I am a mandatory reporter, meaning I have to share any instances of sexual harassment or sexual violence shared with me or that become known to me. I will have to share this information, including names and any details known, to the Title IX Office to connect you with resources. If you would like more information about the resources available, you can ask me at any time this semester. You do not need to tell me why you are asking to get help for a friend, another student, or yourself.

Confidential Resources for Reporting Sexual Misconduct

- Students may speak to someone confidentially which will not generate a report to the Title IX Office by contacting Counseling and Psychological Services at (415) 422-6352 during M-F 9-4pm, or speaking to a clergy member in University Ministry at (415) 422-4463.
- If you need to speak to a mental health clinician immediately, please **call the CAPS 24/7 All Hours Line at 855-531-0761** (available daily, including weekends and holidays, and accepts international calls), Public Safety (415-422-2911), 911, the Suicide Hotline (dial 988), or go to your nearest emergency room
- For off-campus resources, and local Bay Area organizations: <https://myusf.usfca.edu/title-ix/resources>

Learning, Writing, and Speaking Centers

The University of San Francisco offers academic assistance to all students through The Learning Center, The Writing Center, and The Speaking Center. Services are available at no additional cost to USF students and include subject-specific tutoring, writing assistance, and communications-related support. The Learning Center also provides opportunities for academic skill development, through one-on-one academic skills coaching, group workshops, and online resources. The Learning, Writing, and Speaking Centers are located on the Lower Level of Gleeson Library. Please contact them at (415) 422-6713 for further assistance or visit the LWSC [website](#) to make an appointment.

Communication

All course communications, like all other USF communications, will be sent to your USF official email address. You are therefore strongly encouraged to monitor that email account.

Gleeson Library

Looking for help with a research paper or project? Set up a consultation with a Librarian or get 24/7 research help [online](#).

Additional USF Resources

USF Food Pantry

The USF Food Pantry is an intermediate, short-term solution for any registered USF student to receive food and toiletry resources. Students are invited to stop by the pantry located on the first floor of Gleeson Library in the Atrium, and take the items that they need. Items are available on a first-come, first-serve basis until our supply is depleted. You will be asked to check-in via QR code before entering the pantry. For more information and the current schedule, visit the [USF food pantry website](#). If you have further questions, please contact the Pantry Coordinator at usfpantry@usfca.edu or 415-422-4099 (during business hours Monday thru Friday from 9:00am - 5:00pm). You can find out about additional food security resources through the [USF food insecurity resource page](#) and the [CalFresh resources site](#).