CSCI 5573: Advanced Operating Systems
Fall 2020

Instructor
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Short Description
This is a graduate course in operating systems intended to create a foundation for operating systems research or advanced professional practice. Topics include Linux kernel programming, virtualization, light-weight virtualization and OS for small devices.

Prerequisite
- CSCI 3753 and CSCI 4593 or equivalent undergraduate course work in operating systems and computer architecture. These are reasonably firm prerequisites. If you have not taken these courses, you should discuss your situation with me before you enroll in CSCI 5573.

Reading Material
Selected articles and other materials from the Internet.

Class webpage
TBD

Grading (*Weights assigned are tentative*)
- Homework and programming assignments: 40%
- Course project: 20%
- Quizzes and Exams: 40%

Policies

Please see an accessible online version
at https://www.colorado.edu/academicaffairs/student-syllabus-statements

CLASSROOM BEHAVIOR

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Code of Conduct.

REQUIREMENTS FOR COVID-19

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

- maintain 6-foot distancing when possible,

- wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,

- clean local work area,

- practice hand hygiene,

- follow public health orders, and

- if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert CU Boulder Medical Services.

Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct and Conflict Resolution. For more information, see the policies on COVID-19 Health and Safety and classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the "Accommodation for Disabilities" statement on this syllabus.
Before returning to campus, all students must complete the COVID-19 Student Health and Expectations Course. Before coming on to campus each day, all students are required to complete a Daily Health Form. In this class, you may be reminded of the responsibility to complete the Daily Health Form.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home and complete the Health Questionnaire and Illness

[Reporting Form](#) remotely. In this class, if you are sick or quarantined, please alert the instructor via email about your absence due to illness.

ACCOMMODATION FOR DISABILITIES

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

PREFERRED STUDENT NAMES AND PRONOUNS

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

HONOR CODE

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu; 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#).

RELIGIOUS HOLIDAYS

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please notify me of any anticipated conflicts due to religious obligations as early in the semester as possible (at least two weeks before) so that there is adequate time to make necessary arrangements.

See the [campus policy regarding religious observances](#) for full details.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Class attendance

You are expected to attend all lectures (in-person or remote) and stay up-to-date with the material posted on the class webpage. If you miss a lecture, you are responsible for finding out the material covered in that lecture. If you miss an exam or a quiz, a grade of zero will be assigned, unless the you explicitly receive a permission from the instructor. The instructor will grant permissions for only valid reasons.

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Course Content

- Introduction: Review of fundamental concepts
  ◦ Processor mode, system calls
  ◦ Context switch: *schedule*( ) and *switch_to*( ) functions
  ◦ Virtual memory layout
  ◦ Symbol table: *System.map* file
  ◦ System Boot
- Linux Internals
  ◦ */proc* directory
  ◦ *printk( )*, *dmsg*, *klogd*, kernel *oops* and *panic*
  ◦ Loadable Kernel Modules: hello world, device drivers
  ◦ Kernel probes: *kprobes*, *jprobes*, *kretprobes*
  ◦ System call interception and manipulation
  ◦ Linux hotplugging
  ◦ USB Subsystem; USB device drivers
  ◦ Interrupt handlers – Short IRQ, Long IRQ
  ◦ *softirqs*, *tasklets*
  ◦ Work queues
  ◦ Keyboard interrupt handler
  ◦ Scheduling tasks in kernel
- Virtualization
  ◦ Virtual Machine Monitors
  ◦ Machine Virtualization
  ◦ Challenges with Virtualization
  ◦ Full Virtualization: Binary Translation, Shadow Page Tables
  ◦ Paravirtualization: Hypercalls
  ◦ Hardware Assisted Virtualization – *VT-x*, *VMX*
  ◦ Xen, VMWare, Denali, Terra
- Lightweight virtualization
  ◦ *chroot*, *cgroups*, *namespaces*
  ◦ LXC
  ◦ Dockers
- Edge computing
  ◦ Micro-service based architecture
  ◦ EdgeX, Kura
  ◦ Serverless computing
- OS for small devices
  ◦ Android OS
- Influential OS papers from the past (*as time permits*)
  ◦ Multics, Unix, Hydra, VAX/VMS, Mach
  ◦ NFS, FFS, AFS, Coda, Log structured file system, Sprite, FUSE
  ◦ SPIN, Exokernel, L3 Micro-kernel
  ◦ More to include