
COLLEGE OF ENGINEERING, UIC
CS, 594, Linux Kernel Programming, 4 (G)

I. Instructor & Course Details

Xiaoguang Wang

Email address: xgwang9@uic.edu

Drop-In Office Hours (in-person): Thursday 3:30 PM - 4:30 PM or by appointment

Drop-In Hours location: SEO 1331

Blackboard Course Site (should be automatically linked to your Blackboard account)

Students are expected to log into the course site regularly to learn about any developments related to the course, upload assignments, and communicate with classmates. For all technical questions about Blackboard, email the Learning Technology Solutions team at LTS@uic.edu.

Course Modality and Schedule

This course is taught **ON CAMPUS**.

- DAYS and TIMES: Tuesday and Thursday, 09:30 AM - 10:45 AM
- LOCATION: Thomas Beckham Hall | Room 180E

II. Course Information

Catalog Course Description and Prerequisite/corequisite Statement

This course aims to teach students how to program the Linux kernel, implement new or modify existing kernel subsystems, and performance-optimize kernel modules and subsystems by exploiting various time/space tradeoffs and building experience working with a large-scale open-source project. Students will learn the differences between designing, implementing, and debugging application-level and system-level software. These skills are highly desirable for developing operating systems, embedded systems, virtualization infrastructures, and even application software development. In addition, students are expected to read recent research papers in systems design and implementation to catch the state-of-the-art research projects in systems. The course will be a hybrid form of lectures and seminars.

Prerequisite courses: Systems programming (e.g., CS 361), or operating systems (e.g., CS 461) or equivalent, or consent of the instructor.

Course Goals and Learning Outcomes

By the end of the course, students should be able to:

- Assess the functionality, architecture, and implementation of Linux kernel subsystems and modules, including the memory subsystem, process subsystem, scheduling, interrupt handling, virtual file system, block layer, network software stack, and device drivers.
- Design, implement and modify Linux kernel modules for these subsystems.
- Test, debug and evaluate systems software in kernel or user space, including virtualization-based debugging and full software stack debugging and tracing.
- Be familiar with computer systems research.

Required and Recommended Course Materials

- Love, Robert. Linux Kernel Development (3rd Edition). Pearson Education, 2010.

Optional:

- Billimoria, Kaiwan N. Linux Kernel Programming: A comprehensive guide to kernel internals, writing kernel modules, and kernel synchronization. Packt Publishing Ltd, 2021.
- Billimoria, Kaiwan N. Linux Kernel Debugging: Leverage proven tools and advanced techniques to effectively debug Linux kernels and kernel modules. Packt Publishing Ltd, 2022.
- Bovet, Daniel P., and Marco Cesati. Understanding the Linux Kernel: from I/O ports to process management (3rd Edition). O'Reilly Media, Inc., 2005.
- Corbet, Jonathan, Alessandro Rubini, and Greg Kroah-Hartman. Linux Device Drivers (3rd Edition). O'Reilly Media, Inc., 2005.
- Love, Robert. Linux System Programming: Talking Directly to the Kernel and C Library (2nd Edition). O'Reilly Media, Inc., 2013.

Required Technology

- Good knowledge of C programming and the Linux command line is assumed.
- Basic knowledge of computer architecture, operating systems (e.g., Linux), algorithms, and data structures.

Respect for Copyright

Please protect the copyright integrity of all course materials and content. Please do not upload course materials not created by you onto third-party websites or share content with anyone not enrolled in our course.

III. COURSE POLICIES & CLASSROOM EXPECTATIONS

Grading Policy and Point Breakdown

- Quizzes and assignments: [45%]
- Midterm examination: [15%]
- Final project: [30%]
- Class participation and discussions: [10%]

The letter grade will be assigned as: A : ≥ 90 , B : [80, 90), C : [70, 80), D : [60, 70), F : < 60 .

Policy for Missed or Late Work

- Late submission (0, 24 hours] will be accepted with a 15% penalty;
- Late submission (24-48 hours] will be accepted with a 30% penalty;
- Late submission beyond 48 hours will not be accepted.

Attendance / Participation Policy

Policy:

Please email me if you face an unexpected situation that may impede your attendance, participation in required class and exam sessions, or timely completion of assignments.

Other Course Policies

Academic Integrity

As a student and member of the UIC community, you are expected to adhere to the [Community Standards of academic integrity](#), accountability, and respect. Please review the [UIC Student Disciplinary Policy](#) for additional information.

Email Expectations

Students are responsible for all information instructors send to your UIC email and Blackboard accounts. Faculty messages should be regularly monitored and read in a timely fashion.

IV. COURSE SCHEDULE

Weekly Schedule of Class Topics

- Week 1:** Intro to Linux kernel programming and software engineering techniques for large projects (version control, toolchains, configure, make, kernel installation, kernel code exploration/browsing).
- Week 2:** Isolation, system calls and Linux kernel data structures (linked list, hash table, rb-tree, radix tree, bitmap, etc.).
- Week 3:** Kernel debugging, tracing techniques (printk, ftrace, QEMU/KVM debugging w/ GDB).
- Week 4:** Process management and process scheduling
- Week 5:** Interrupt handling: top half, bottom half

- Week 6:** Kernel synchronization
Week 7: Timer and time management
Week 8: Memory management, address space
Week 9: Virtual file system, page cache, and page fault
Week 10: Filesystem and block I/O
Week 11: Spring break
Week 12: Virtualization
Week 13: Paper reading and discussion
Week 14: Paper reading and discussion
Week 15: Paper reading and discussion, Final Project Presentation

Disclaimer

This syllabus is intended to give the student guidance on what may be covered during the semester and will be followed as closely as possible. However, as the instructor, I reserve the right to modify, supplement, and make changes as course needs arise. I will communicate such changes in advance through in-class announcements and in writing via Blackboard Announcements.

V. ACCOMMODATIONS

Disability Accommodation Procedures

UIC is committed to full inclusion and participation of people with disabilities in all aspects of university life. If you face or anticipate disability-related barriers while at UIC, please connect with the Disability Resource Center (DRC) at drc.uic.edu, via email at drc@uic.edu, or call (312) 413-2183 to create a plan for reasonable accommodations. To receive accommodations, you will need to disclose the disability to the DRC, complete an interactive registration process with the DRC, and provide me with a Letter of Accommodation (LOA). Upon receipt of an LOA, I will gladly work with you and the DRC to implement approved accommodations.

Religious Accommodations

Following [campus policy](#), if you wish to observe religious holidays, you must notify me by the tenth day of the semester. If the religious holiday is observed on or before the tenth day of the semester, you must notify me at least five days before you will be absent. Please submit [this form](#) by email with the subject heading: **"YOUR NAME: Requesting Religious Accommodation."**

VI. CLASSROOM ENVIRONMENT

Inclusive Community

UIC values diversity and inclusion. Regardless of age, disability, ethnicity, race, gender, gender identity, sexual orientation, socioeconomic status, geographic background, religion, political ideology, language, or culture, we expect all members of this class to contribute to a respectful, welcoming, and inclusive environment for every other member of our class. If aspects of this

course result in barriers to your inclusion, engagement, accurate assessment, or achievement, please notify me as soon as possible.

Name and Pronoun Use

If your name does not match the name on my class roster, please let me know as soon as possible. My pronouns are *[he/him; they/them]*. I welcome your pronouns if you would like to share them with me. For more information about pronouns, see this page: <https://www.mypronouns.org/what-and-why>.

Community Agreement/Classroom Conduct Policy

- Be present by turning off cell phones and removing yourself from other distractions.
- Be respectful of the learning space and community. For example, no side conversations or unnecessary disruptions.
- Use preferred names and gender pronouns.
- Assume goodwill in all interactions, even in disagreement.
- Facilitate dialogue and value the free and safe exchange of ideas.
- Try not to make assumptions, have an open mind, seek to understand, and not judge.
- Approach discussion, challenges, and different perspectives as an opportunity to “think out loud,” learn something new, and understand the concepts or experiences that guide other people’s thinking.
- Debate the concepts, not the person.
- Be gracious and open to change when your ideas, arguments, or positions do not work or are proven wrong.
- Be willing to work together and share helpful study strategies.
- Be mindful of one another’s privacy, and do not invite outsiders into our classroom.

Content Notices and Trigger Warnings

Our classroom provides an open space for a critical and civil exchange of ideas, inclusive of a variety of perspectives and positions. Some readings and other content may expose you to ideas, subjects, or views that may challenge you, cause you discomfort, or recall past negative experiences or traumas. I intend to discuss all subjects with dignity and humanity, as well as with rigor and respect for scholarly inquiry. If you would like me to be aware of a specific topic of concern, please email or visit my Student Drop-In Hours.

VII. RESOURCES: Academic Success, Wellness, and Safety

We all need the help and the support of our UIC community. Please visit my **drop-in hours** for course consultation and other academic or research topics. For additional assistance, please contact your assigned college advisor and visit the support services available to all UIC students.

Academic Success

- [UIC Tutoring Resources](#)

- College of Engineering [tutoring program](#)
- [Equity and Inclusion in Engineering Program](#)
- [UIC Library](#) and [UIC Library Research Guides](#).
- [Offices](#) supporting the UIC Undergraduate Experience and Academic Programs.
- [Student Guide for Information Technology](#)
- [First-at-LAS](#) Academic Success Program, focusing on LAS first-generation students.

Wellness

- **Counseling Services:** You may seek free and confidential services from the Counseling Center at <https://counseling.uic.edu/>.
- Access [U&I Care Program](#) for assistance with personal hardships.
- **Campus Advocacy Network:** Under Title IX, you have the right to an education that is free from any form of gender-based violence or discrimination. To make a report, email TitleIX@uic.edu. For more information or confidential victim services and advocacy, visit UIC's Campus Advocacy Network at <http://can.uic.edu/>.

Safety

- [UIC Safe App](#)—PLEASE DOWNLOAD FOR YOUR SAFETY!
- [UIC Safety Tips and Resources](#)
- [Night Ride](#)
- [Emergency Communications:](#) By dialing 5-5555 from a campus phone, you can summon the Police or Fire for any on-campus emergency. You may also set up the complete number, (312) 355-5555, on speed dial on your cell phone.