

CS614: Linux Kernel Programming

Lecture hours: MW 2PM - 3.15PM

Venue: RM 101

Teaching Tools/Platforms

Class page: Link to lecture resources and other information

(<https://cse.iitk.ac.in/users/deba/cs614/index.html>)

Piazza: All communications related to the course, discussion, Q/A

(<https://piazza.com/iitk.ac.in/secondsemester2023/cs614>)

Canvas: To be used to upload assignments (<https://canvas.cse.iitk.ac.in/courses/67>)

Meeting Hours

The scheduled office hour for the course is every Thursday 3PM - 5PM. Students are encouraged to ask questions in the class Piazza page. One-on-one meetings can be scheduled on-a-need basis.

Course Objective

Understanding internals of a full fledged operating system is desirable to develop new OS level functionalities in research and technology development. Goal of this course is to expose students to Linux OS (a.k.a. Linux Kernel) internals to provide an up-close view of its design mechanisms and features. At the end of the course, students are expected to be confident to approach designing new OS level features when required. The course will be primarily structured around hands-on exercises and assignments involving understanding/extending the Linux kernel code base for different subsystems. For some of the concepts, recent research works proposing extensions/optimizations will also be covered.

Prerequisite

UG course on Operating Systems (for Masters and PhD. students). For IIT Kanpur UG students, CS330 is a prerequisite. Good programming skills in C/C++. Exposure to large code bases, low level programming and debugging is desirable.

Course Contents

The course will primarily focus on the following topics.

1. Introduction: Operating system background, Linux kernel overview, Kernel hacking techniques, Overview of Linux kernel execution contexts like Processes, Threads, Kernel threads, Interrupts, Bottom halves/softIRQs

2. Process management: Linux kernel scheduler, Kernel synchronization issues and solutions
3. Memory management: Virtual memory, Kernel memory allocators
4. Filesystems and block layer: VFS layer, File systems (EXT4, XFS, F2FS), Page cache, Block I/O interfacing, I/O scheduler
5. Device drivers: Device probe and initialization, Interrupt handling, DMA

Detailed breakdown of lecture hours for different topics is provided in the following table.

Module	Topic	No. of lectures
Introduction	OS background, Kernel Hacking techniques, Linux execution contexts	8
Process management	Linux kernel scheduler, Kernel synchronization issues and solutions	8
Memory management	Virtual Memory, Kernel memory allocation mechanisms	10
Filesystems and block layer	VFS layer, file systems (EXT4, XFS, F2FS), Page cache, Block I/O interfacing, I/O scheduler	9
Device drivers	Device probe and initialization interrupt handling, DMA	5
Total lectures		40

Grading policy

Quizzes: 10% (Unannounced)

Assignments: 40%

Mid-semester Examination: 15%

End-semester Examination: 35%

Course Policies

- Attend classes regularly. Slides may not contain everything discussed during the lectures.
- Do not be tempted to adopt any unfair means as it would result in serious repercussions. Please refer to the department Anti-Cheating policy page (<https://cse.iitk.ac.in/pages/AntiCheatingPolicy.html>)
- Switch off your mobile phones etc. during lecture hours

Books and References

1. Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, *Operating Systems: Three Easy Pieces*. Online 2018.
2. Daniel P. Bovet, Marco Cesati, *Understanding the Linux Kernel - from I/O ports to process management* (Third ed.), O'Reilly 2005.
3. Robert Love. *Linux Kernel Development* (Third ed.), O'Reilly 2010.
4. Jonathan Corbet, Alessandro Rubini, Greg Kroah-Hartman *Linux Device Drivers* (Third ed.)
5. Research papers, Architecture manuals, White papers