

# CS550: Operating Systems

Spring 2017, Sections 02 and 03

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## Syllabus

This course will cover classical and current concepts in Operating Systems. Topics include:

- Concurrency
- Virtual Memory Systems
- Scheduling
- File Systems and I/O
- Virtualization
- Security and Reliability
- System Design Principles

We will cover a mix of background material followed by research papers in each topic. Assignments and course projects will help you get your hands dirty with Linux kernel.

**Credit hours and course expectations:** This course is a 3-credit course, which means that students are expected to do at least 9 to 9.5 hours of course-related work or activity each week during the semester. This includes scheduled class lecture/discussion meeting times as well as time spent completing assigned readings, studying for tests and examinations, participating in lab sessions, preparing written assignments, and other course-related tasks.

## Prerequisites:

- **CS350 -- Undergraduate OS. You must be familiar with the fundamentals concepts in Operating Systems as covered in CS350. This course is not a substitute for an undergraduate OS course.**
- You must be proficient with C programming.
- Proficiency in the use of a debugger (such as gdb) is expected. You must know how to debug your own code.
- You must be comfortable working and programming in the Linux environment.

## Evaluation Criteria:

- 60% - Class Tests
  - Test 1 : March 8 at 3:30pm in TBA
  - Test 2 : April 5 at 3:30pm in TBA
  - Test 3 : May 15 at 5:40pm in TBA
- 40% - Assignments

## Time and Location:

- Lectures: MW 3:30pm to 5pm Science Library 212 (SL212)

**Instructor:** [Kartik Gopalan](#), [kartik@binghamton.edu](mailto:kartik@binghamton.edu)

**Office Hours:** Mon-Wed 2:30-3:30pm in ENGB Q-17, and 5:00--5:30 in SL212 after class. Feel free to set up an appointment for other times.

### Teaching Assistants:

- Piush Sinha (psinha1@binghamton.edu) Office Hours: Tuesday 1:30pm-3:30pm, Location: ENGB G-25
- Spoorti Doddamani (sdoddam1@binghamton.edu) Office Hours: Friday 10am-12noon, Location: ENGB G-25

### Recommended Textbook:

The following two textbooks are recommended. The second book is free online. You DON'T need to buy either of them.

1. *Modern Operating Systems*, Andrew Tanenbaum, Prentice Hall; 4th edition
2. [\*Operating Systems: Three Easy Pieces\*](#)  
Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau  
Arpaci-Dusseau Books  
March, 2015 (Version 0.90)

### Other Recommended Material:

- Kernighan, Ritchie, The C Programming Language
- Linux Device Drivers, 3rd Edition by Jonathan Corbet, Alessandro Rubini, and Greg Kroah-Hartman. (This book is also available online at <http://lwn.net/Kernel/LDD3/>).
- Virtual Machines: Versatile Platforms for Systems and Processes, By James E. Smith Jim, Jr. Smith, Ravi Nair.
- Unix Network programming, Vol 1: The Socket Networking API (3rd edition), by W. Richard Stevens, Bill Fenner, Andrew M. Rudoff, Addison-Wesley Professional.
- Silberschatz, Galvin, Gagne, Operating System Concepts; 7th or 8th edition

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### Lecture Slides

Please clear your browser's cache and reload this page to see the latest listing of slides below.

1. [Introduction](#)
2. [Processes](#)
  - [Recorded Lecture](#)
  - References: Chapter 4 of OSTEP book and Chapter 2 of Tanenbaum's book
3. [Inter Process Communication](#)
  - [Recorded lecture](#)
  - Chapter 5 of OSTEP book
  - Unix man pages
  - Chapters 7 to 10, and 14, Advanced Programming in Unix Environment, by Richard Stevens.
4. [OS and Its Three Pieces](#)
  - Chapter 1 of OSTEP book.
5. [Threads](#)
  - [Recorded Lecture](#)

- Chapters 26 and 27, OSTEP book
- Chapter 2 (Section 2.2), Modern Operating Systems, Andrew Tanenbaum
- Chapter 11: Advanced Programming in Unix Environment, by Richard Stevens
- 6. [Kernel Modules](#)
  - [Example Code Kernel Modules](#)
- 7. [System Calls](#)
  - [Additional slides explaining syscall implementation](#)
- 8. [Concurrency - Race Conditions and Deadlocks](#)
  - [Recorded Lecture](#)
  - Chapters 2 (2.3) and 6, Tanenbaum's Modern OS
- 9. [Concurrency - Semaphores, Condition Variables, and Producer Consumer](#)
  - [Recorded Lecture](#)
  - Chapters 2 (2.3) and 6, Tanenbaum's Modern OS
- 10. [Events vs Threads : Ousterhout's talk](#)
- 11. ["The UNIX time-sharing system"](#), Dennis M. Ritchie and Ken Thompson, 1974
  - [Paper](#)
  - [Undergraduate Background on File Systems](#)
    - [Recorded Lecture](#)
    - Chapter 4: Modern Operating Systems - Andrew Tanenbaum
- 12. [I/O Models](#)
  - [Recorded Lecture](#)
  - Chapter 6, Unix Network Programming, 3rd Edition, by Richard Stevens
- 13. [Virtual Memory Management](#)
  - [Recorded lecture](#)
  - Chapter 3, Tanenbaum's book
- 14. [Memory Management and Superpages](#)
  - Paper: [Practical, Transparent, Operating System Support for Superpages](#)
- 15. [Segmentation](#)
  - [Recorded Lecture](#)
  - Chapter 3, Tanenbaum's book
- 16. [RAID](#)
  - [Recorded Lecture](#)
  - Chapter 5, Tanenbaum's book
- 17. [Introduction to Virtual Machines](#)
  - [Recorded Lecture](#)
  - [\[smith03overview\]](#) Chapter 1, "Virtual Machines - Versatile platforms for Systems and Processes", Smith and Nair.
  - Section 8.3 Tanenbaum 3rd Edition
  - Chapter 7 Tanenbaum 4th Edition
- 18. [Live Migration of Virtual Machines](#)
  - [C. Clark et. al, "Live migration of virtual machines", NSDI 2005](#)
  - [M. Hines, U. Deshpande, K. Gopalan, "Post-copy live migration of virtual machines", Operating Systems Review 2009.](#)
- 19. [Operating-System-Level Virtualization \(Containers\)](#)
  - Various sources on the internet
- 20. [System Security](#)
  - [Recorded Lecture](#)
  - Chapter 9 Tanenbaum's book
- 21. [Principles of System Design](#)
  - [Hints for Computer System Design](#)

- Chapter 6 from Srinivas and Keshav's book.

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## Assignments and Labs

- [GCP Instructions](#)
- [Network Boot Image Instructions](#)
- [Assignment 1: Process Hierarchy](#)
  - Due: Feb 15th.
  - 7% Grade

**Assignment Submission:** Submit your assignment on the blackboard as one tar-gzipped file (generated using the *tar* command with *cvzf* options). In the tar-gzipped file, include all your code, a README file, and a Makefile. If you do not know how to do this, please contact us for help. DO NOT submit each file individually. DO NOT include the entire linux kernel (for kernel programming assignments) -- include only the files you change. DO NOT include object files (.o) or any executable files.

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## Tests and Solutions

- Sample tests and solutions will be posted here.

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