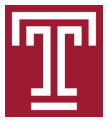
CIS 5512 - Operating Systems
Introduction

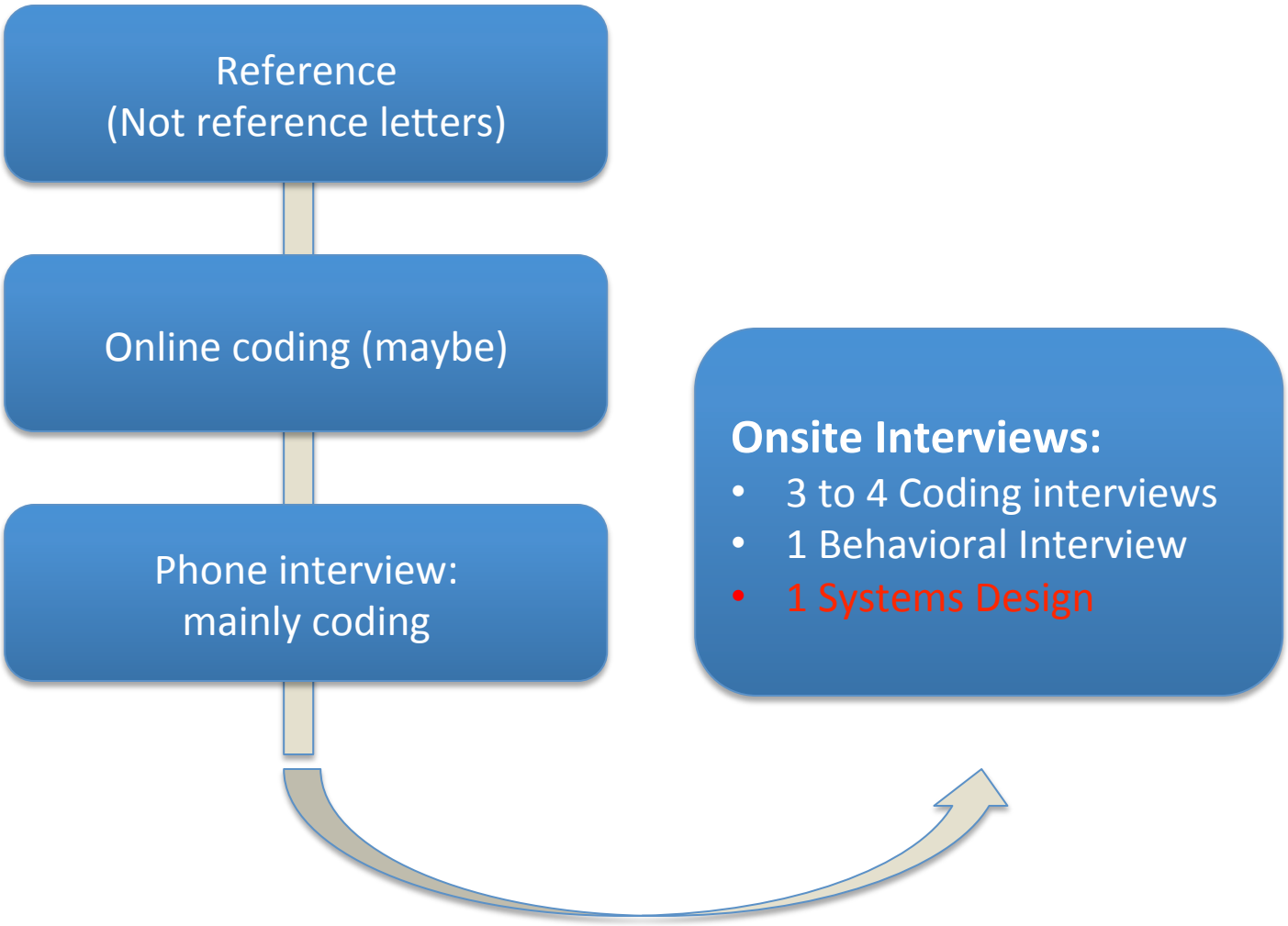
Professor Qiang Zeng

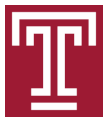
About me

- PhD in CSE, Penn State
- Enjoy hacking kernels and systems s/w
- Industry experiences:
  - IBM Watson Research Center
  - NEC Lab America
  - Yahoo
  - Symantec
- Office hours: 3-5pm Thur, SERC 328
- Questions, feedbacks, and comments are highly encouraged



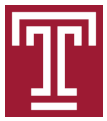
Job hunting


Reference
(Not reference letters)
Online coding (maybe)
Phone interview:
mainly coding
Onsite Interviews:
• 3 to 4 Coding interviews
• 1 Behavioral Interview
• 1 Systems Design



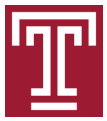
Tips for job hunting

- Contact schoolmates and friends to get internal references
- Coding: leetcode, topcoder, careercup
- Stay in the Bay Area during job hunting; you may get onsite interviews directly (without going through online and phone interviews)
- **Learn this course well**



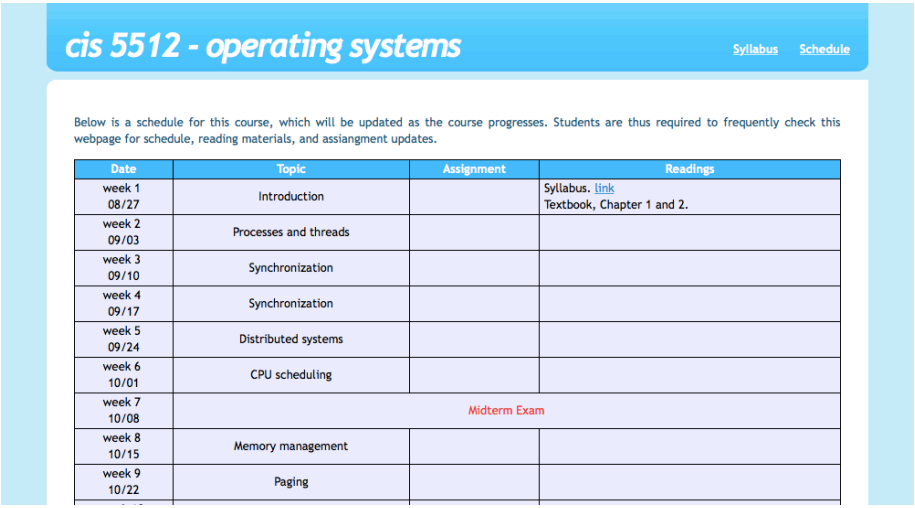
Course prerequisites

- Architectures and systems basics
  - CIS 3207 or CIS 5012
- Data structures
  - CIS 3223 or CIS 5011
- C programming



Course website

- http://cis.temple.edu/~qzeng/cis5512-fall2017/
- Please check this website frequently for updates of assignments, readings, and slides
- Readings ahead of classes are required

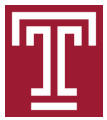


cis 5512 - operating systems

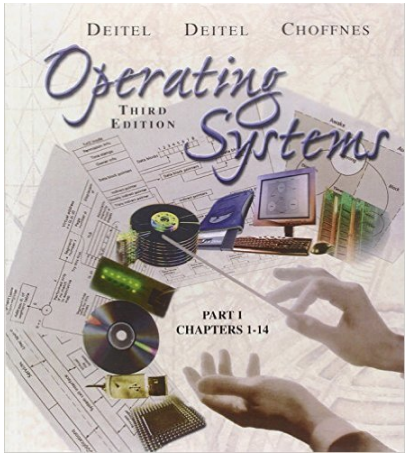
Syllabus Schedule

Below is a schedule for this course, which will be updated as the course progresses. Students are thus required to frequently check this webpage for schedule, reading materials, and assiangment updates.

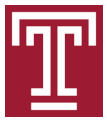
Date	Topic	Assignment	Readings
week 1 08/27	Introduction		Syllabus. link Textbook, Chapter 1 and 2.
week 2 09/03	Processes and threads		
week 3 09/10	Synchronization		
week 4 09/17	Synchronization		
week 5 09/24	Distributed systems		
week 6 10/01	CPU scheduling		
week 7 10/08	Midterm Exam		
week 8 10/15	Memory management		
week 9 10/22	Paging		



Textbooks

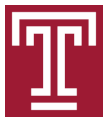


- Required
  - "Operating Systems", Deitel, Deitel, and Choffnes, 3rd edition 2004
- Recommended
  - "Operating Systems: Principles and Practice", Anderson and Dahlin, 2nd edition, 2014
  - "Linux Kernel Development", Love, 3rd edition, 2010



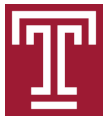
Grading

- Midterm (35%), Final (35%), Projects(30%)
- Three programming assignments
  - Mandatory: three students per group (two-student group needs the instructor's special approval)
  - Cheating will lead to "F"
  - Late submission will be rejected directly; no excuse



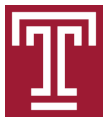
What this course is about

- *How* are the subsystems of an OS built?
  - The beautiful designs behind them
- *Why* have they been built this way?
  - What are the trade-offs?
  - Can the ideas be generalized to your research?



What this course is NOT about

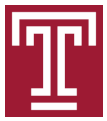
- NOT a distributed OS course
- NOT a cloud computing and virtualization course
- NOT an embedded system course



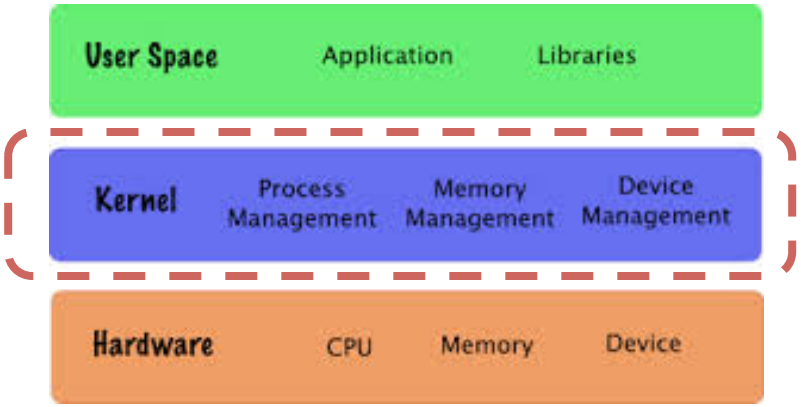
Why is an operating system needed?

- Services
  - Hundreds of system calls
- Resource management
  - Processor, memory, disk
- Protection
  - Isolation and access control
- Inter-process communication (IPC)
  - One process talks with another

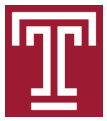
Analogy - think about a bank:
Bank facilities – computer hardware
Staff – operating system
Customers – user programs



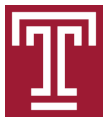
Three major subsystems



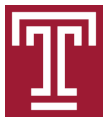
- Process management
  - Processes, threads, synchronization
- Memory management
  - Paging and swapping
- Device management
  - File systems, networks, display



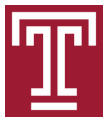
What is the difference between process and thread?



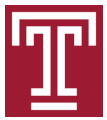
How do processes share CPU?



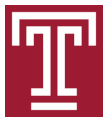
What is segmentation fault?



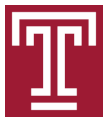
How do processes share memory?



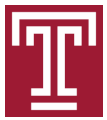
What happens upon a keystroke?



How to optimize your programs?

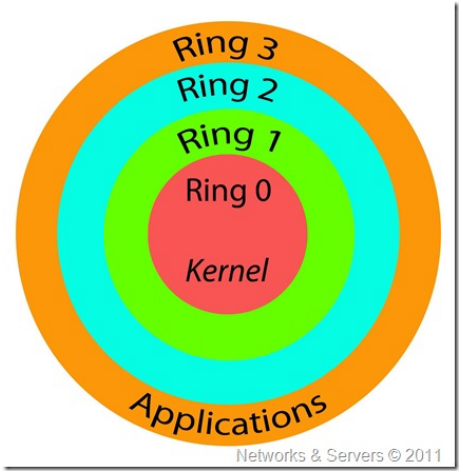


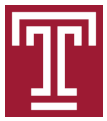
What are device drivers?



CPU modes

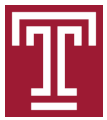
- CPU modes: kernel mode and user mode
  - Kernel mode can issue privileged instructions
- Implemented through protection rings
  - Introduced by Multics, the predecessor of Unix
  - X86 CPUs Kernel mode: Ring 0; user mode: ring 3





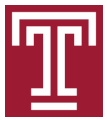
Why are Protection Rings needed?

- Fault isolation: the program crash can be captured and handled by a lower ring
- Privileged instructions can only be issued in ring 0, which makes resource management, isolation and protection possible; e.g.,
  - I/O: read/write disks, etc.
  - Physical memory allocation

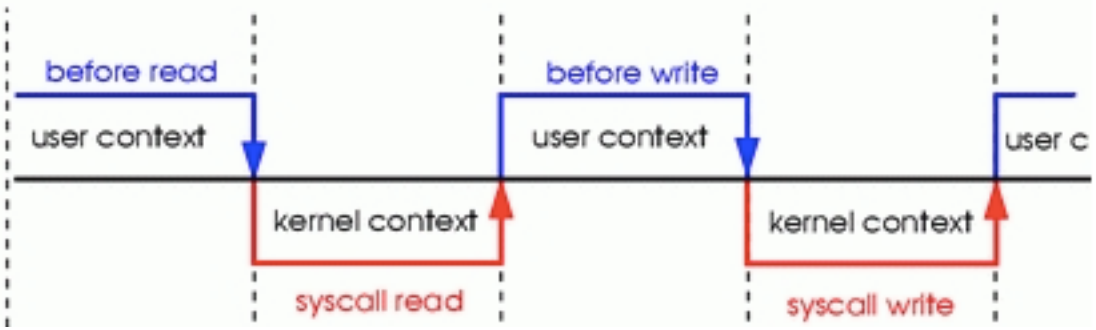


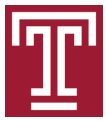
Questions

- If read/write disks are privileged instructions, how does a user program read/write?
  - System calls
  - When a system call is issued, the process goes from user mode (ring 3) to kernel mode (ring 0)
  - `fprintf` libc call -> read/`write` system call -> I/O
- When a system call is issued, how does the CPU mode change?
  - User mode -> kernel mode -> user mode



User mode and kernel mode are interleaved





How to interpret the output of the `time` command

```
$ time any-command
        real    0m1.734s
        user    0m0.017s
        sys     0m0.040s
```

- Real: wall clock time
- User: CPU time spent in user-mode
- Sys: CPU time spent in kernel-mode
- Actual CPU time: user + sys