Wrapup and Final Review

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Logistics

- Assignment 4 due at 5:00pm on Thursday, 1 December 2016
- Extra credit project due at 11:59pm on Friday, 2 December 2016
- Final on Monday, 5 December 2016, 12:30-2:30, 242 Gerlinger
  - No book
  - No notes
  - No computers

Online Questionnaires

- It is important to me that you complete the online questionnaires on DuckWeb. I attempt to address issues raised by students when I next teach the course.
- I like to know what you particularly liked about the course, and welcome constructive comments on how I can make it better.
- Your final letter grades will be made available only on DuckWeb; I understand that these grades are held if you do not complete a course evaluation questionnaire.

What have we covered?

- Before midterm
  - Abstract Data Types in C
  - OS Structures and system calls
  - Processes
  - Interprocess Communication
  - Threads
  - CPU Scheduling
  - Real-time systems
  - Synchronization and Deadlocks
- After midterm
  - Main memory
  - Paging/Virtual memory
  - Caches
  - Virtual Machines
  - File system interface
  - File system implementation
  - Mass-storage systems
  - I/O systems
  - Protection

Topics that are "fair game" for the final

- Abstract data types in C
- Process Scheduling
- Thread synchronization
- Main memory
- Caches
- Virtual memory
- File System interface & implementation
- I/O systems
- Mass Storage Systems
- Protection
- Real-time systems

What to expect on the final?

- 120 minute exam
- 6 questions worth 20 points each
- All areas on the previous slide are fair game
- Mix of short answer questions, algorithmic simulation, program sketches

Study Advice

- Read relevant chapters of the book ***AGAIN***
- Review all lecture slides and the Cache handout
- Review assignments and midterm
- Review Projects 0, 1, 2
  - In particular, what were they attempting to emphasize?

Abstract Data Types in C

- Public interface defined in .h file
- Opaque structure declaration in .h file
- Actual structure declaration in .c file
- Use of malloc()/free() for ADT instance data structure
- Accessor functions
- Mutator functions
- Iterators

Process/Thread Scheduling

- Process/Thread lifecycle
- FCFS
- SJF
- Round Robin
- Multi-level feedback queues
- Turnaround time, waiting time, response time

Thread synchronization

- Critical sections
- Conditional critical sections
- Locks and Condition Variables
- Pthreads
- Understand how race conditions come about and how to address them with critical sections and/or conditional critical sections
- Understand how to build thread-safe ADTs using mutexes and condition variables

Real-time systems

- Pre-emptive, priority-based scheduling
- Minimize Latency
- Periodic task model
  - Each task defined in terms of (offset, period, execution time)
- Valid versus feasible schedule
- Fixed-priority versus Dynamic-priority scheduling algorithms
- Rate-monotonic
- Earliest deadline first
- Total utilization and feasible schedules

Synchronization and Deadlock

- TestAndSet and Swap instructions for low-level synchronization
- Pthread mutexes and condition variables
- Semaphores
- 4 necessary and sufficient conditions for deadlock (mutual exclusion, hold and wait, no preemption, circular wait)
- Resource allocation graphs, determining if a graph exhibits deadlock

Main memory

- Swapping
- Degree of multiprogramming
- Allocation
  - Contiguous vs. non-contiguous (paging and/or segmentation)
- Fragmentation - internal or external
- Page tables, TLBs
  - Virtual-physical translation
  - Page table structure, entries
  - Effect memory access times
  - Valid, dirty, reference bits

Virtual memory

- Page fault handling
  - Effect memory access times
- Page replacement algorithms
  - Clock
  - 2-handed clock
- Aspects of virtual memory
  - Copy-on-write
  - Shared pages between processes
  - Memory-mapped files
- Thrashing
- Working sets
- Understand how application behavior can affect paging

Caches

- SRAM vs DRAM
- Virtual vs Physical caches
- Instruction vs Data caches
- Cache hierarchies
- Write-through caches
- Cache lines
- Cache coherency protocols for multicore systems
- Effective memory access times

File system interface & implementation

- File system concepts
  - File system layers
  - Files, directories
  - Operations and usage
- File system implementation
  - What's on disk? How is it formatted? How do we keep track of the blocks in a file?
  - Contiguous, linked, indexed allocation
  - What's in memory? How is it represented?
- File system usage
  - File allocation
  - File caching
  - Free space management

I/O systems

- I/O hardware
  - Devices
  - Controllers
- Interfacing with I/O devices
  - Polling
  - Interrupts
  - DMA
- Types of I/O operation
- I/O system structure in OS

Mass Storage Systems

- Understand sectors, tracks, cylinders, surfaces
- Understand how linear array of blocks are mapped to cylinders and surfaces
- Understand different disk scheduling algorithms: FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK
- Understand when and why you would use each of these

Protection

- Access matrix as the model for protection
  - Rows are domains
  - Columns are objects
  - Each cell indicates what operations that domain can perform on that object
- Access matrix partitioned by column – access control list
- Access matrix partitioned by row – capability list
- Revocation
- Authentication
- Authorization
- Domain switching

Planning your UO career

- If you are interested in what you've learned in this class and want to pursue systems concepts more deeply, you may also want to take the following courses:
  - CIS 431: Parallel Computing
  - CIS 432: Networking
  - CIS 433: Computer and Network Security
- Also take a look at 407/507 seminars that are offered each quarter; some are on systems topics (e.g. Winter 2016 I offered a seminar on Complex Event Processing Systems)
- Many professors are willing to work with enthusiastic students on systems projects
- In particular, if you enjoy and have done well in the projects in 415, I am willing to supervise senior theses for enthusiastic students.

Thanks to …

- Al Malony for sharing his materials from Fall 2014 section of CIS 415
- Gene Osborne– GTF
- You – it has been a pleasure to work with you
- Good luck next Monday
- I hope you have an excellent winter holiday.
- If you are graduating, I wish you the very best in your career going forward.