Computer Science 346
Operating Systems
Fall 2020

Instructor: Dr. Chris Healy
My office is located in Room 200-I in Riley Hall. My office hours are MWF 9:00 – 11:00, Thursdays 2:00 – 2:50, and also by appointment. Please see me if you ever have any questions during the course. I can be reached by phone (294-2233) and e-mail (chris.healy@furman.edu).

Class meetings
MWF 11:30 – 12:20 in 204 Riley Hall, with labs on Tuesday 3:00 – 5:00 online.

Course description
An introduction to the design of modern operating systems. Topics include processes, scheduling, synchronization, deadlock, file and memory management, I/O, security and distributed systems.

Web site
Notes and other materials can be found here: http://cs.furman.edu/~chealy/cs346

Textbook
Operating System Concepts Essentials, by Silberschatz, Galvin and Gagne, 2nd edition, 2013, published by Wiley. We will cover additional topics as time permits.

Grade calculation

25% Labs and homework
25% Test #1, Friday, September 18
25% Test #2, Friday, October 23
25% Final Exam, Friday, December 4, 12:00 – 2:30 p.m.

Please note the dates/times of these exams. Any appropriate documentation supporting special arrangements necessary for any test must be given to me during the first week of class. If you are authorized to take an exam remotely, then you are required to send your exam paper to me electronically by the end of the class period.

Homework
Please note the following policy on labs and homework, because it may differ from other classes you have had. Each student is required to turn in an individual homework submission. Getting help from someone else or collaborating with another student when working on homework is allowed. If you do get help, please include a statement at the end of your homework paper that says who you worked with, which questions you needed help with, and to what extent you still do not understand how to do the problem(s). Your homework grade will not be affected by this statement. Examples of such a statement might be: "Donald Duck and I worked on the second problem together, and now I fully

understand how to do it." Or, "I did not know how to do the last problem. Mickey Mouse showed me how to do it, but I still would not be able to do it myself."

If you don't include a statement of assistance at the end of your homework, I will assume that you were able to complete it by yourself. The reason why I am tracking whether you needed help on certain problems is so that I can contact you about what you don't understand. My mission is to help you master all of the material of the course.

Plagiarism means receiving assistance without the proper attribution, and this will not be allowed. Also, if you are using my collaboration policy merely as a way for other people to do your homework for you, this will also not be allowed. Cheating penalties will be substantial, up to and including an automatic failing grade in the course. The minimum penalty for cheating related to homework will be a failing grade on the assignment.

Attendance

If you are attending the class remotely, it is your responsibility to make sure your presence known to the instructor. If you are absent from a test, you will earn a score of zero, unless your absence is excused. Excused absences include illness (doctor's note elaborating your incapacitation will be required), circumstances beyond your control or a required extra-curricular activity in which you are an official representative of the university. In any case, you are required to submit written documentation to excuse an absence. If your absence is excused, then I will assign you to a make-up exam.

Preparation

I estimate that you will need to study up to 5 hours per week for this class. Studying on a consistent daily schedule is more important than the number of hours. Study includes reviewing notes, working problems from the textbook, becoming acquainted with the material to be discussed in the next class, completing homework assignments and preparing for exams. Studying on a consistent schedule each week will work far better for you than cramming before a test. Don't forget the most important thing – I am here for you. Please come to my office anytime for help or advice in this course.

Tentative pacing schedule

Week	Days	Chapter	Topics
1	– – 19 – 21	1	OS definition, responsibilities, big picture; Kernel versus user mode, overview of OS issues
2	24 – 26 – 28	2-3	OS services, user interface, system calls and utilities; OS implementation, kernel structure, virtual machines Processes: contents, scheduling basics, creation, termination
3	31 – 2 – 4	3-4	Inter-process communication, shared memory, message passing, buffering Client-server communication, sockets, remote procedure call Threads: definition, purpose, types, signals
4	7 – 9 – 11	4-5	User thread implementation: POSIX, Java, examples Process synchronization, solution criteria Peterson's solution, semaphores, deadlock, starvation, bounded buffer, readers/writers
5	14 – 16 – 18	5	Dining philosophers, monitors, condition variables Synchronization in Java Test #1 on Friday
6	21 – 23 – 25	6	CPU scheduling: general ideas, criteria, simple algorithms, load preemption, estimating time, priority scheduling, round robin Multilevel queue, thread scheduling, processor affinity, multicore Real-time scheduling: earliest deadline first, rate monotonic
7	28 – 30 – 2	5.11, 7	Deadlock: necessary conditions, directed graph, how to handle, prevention, avoidance, safe state, Banker's algorithm, detection Main memory: addresses, swapping, allocation, paging, Page table, segmentation
8	5 – 7 – 9	8	Virtual memory, demand paging, page fault, copy-on-write Page replacement, FIFO, LRU Page size, frame allocation, thrashing, working set model, memory mapping Kernel memory, slab, pre-paging, TLB, memory-aware code, locking pages
9	12 – 14 – 16	9	Mass storage: disk anatomy, disk scheduling Disk management, swap space, RAID File systems: type & structure of files, directories
10	19 – 21 – 23	10	Mounting, file sharing, remote file system, consistency, protection, permissions Layers & structure of file systems, opening a file, multiple and virtual file systems, directory representation Test #2 on Friday
11	26 – 28 – 30	11-12	Disk allocation: contiguous, linked, file allocation table, indexed, indirectio free space File system efficiency, performance, recovery; network file system I/O systems: HW components, polling & interrupts, direct memory access I/O system calls, role of kernel, buffers, performance
12	2 – 4 – 6	13	Protection: access control matrix, domains, implementation Security: areas, coding errors, malicious code Dictionary attack, salt, cryptography, RSA, Diffie-Hellman, digital signature
13	9 – 11 – 13	14	Penetration test, intrusion detection, anomaly detection Aggressiveness of security Special topics (e.g. Real-time and Cyber-physical systems)
14	16 – 18 – 20	15	Cyber-physical systems
X	– – – – 4		Finial Exam 12:00 Friday

Guiding principles for students in Computer Science classes

1. We are here to learn and explore.
    a. Seek discussions with the instructor and classmates about the material to reinforce your understanding, practice communicating ideas.
    b. Have fun. Live in the moment (i.e. don't dwell too much on the difficulties of yesterday or tomorrow). Enjoy the journey and intellectual feast. Be enthusiastic about what you are doing.

2. You can be successful in this class. Every day is an opportunity for an epiphany. Don't let mistakes or setbacks hold you back. After some effort, things can suddenly click in your mind. Your eagerness to learn is more important than intellectual ability in determining your success in this course.

3. Learn by doing, not just passively reading, listening or watching.
   Each study period needs to have a clear goal.
   Pay attention to the big picture and the facts that you are collecting.

4. Be organized. Take notes on what you read. Review earlier material as needed. Create a cumulative study outline every few weeks. Maintain a portfolio of your work.

5. Be patient when solving a homework or lab problem.
    a. There is no need to rush.
       Don't worry if your first attempt at a solution is wrong.
       Read all instructions and be methodical.
       Take time to gather your thoughts.
       Deliberately write out your thought process and plan of attack.
    b. A computer program or other homework assignment may take up to several hours to complete. In programs you need to comment your code as you go, because you will quickly forget what looks obvious right now! Realize that you don't need to finish everything in one sitting.
    c. Break up large problems into small, more manageable pieces.
    d. Don't get bogged down with too many mechanical details. Computing is all about removing tedium from routine tasks.

6. Be curious, and always ask questions.
    a. Find a topic or application that you are enthusiastic about.
    b. Consider alternative solutions to a problem.
    c. When finishing a problem, ask yourself if this problem or its solution lends itself to other problems.

7. Computer science is about logic, structured thinking, information, communication and problem solving. Thus, it has connections to many other fields in the sciences, humanities and social sciences. You will find the analytical techniques useful in your career.