CSCI 432: Operating Systems

Fall 2023

General Info

Instructor:	Jeannie Albrecht
Email:	`jeannie@cs.williams.edu`
Office:	TCL 305
Office Hours:	TBD or by appt
Class Meetings:	TTh 9:55-11:10am in Schow 030A
Webpage:	`http://www.cs.williams.edu/˜jeannie/cs432/index.html`
Experimental Textbook:	*Operating Systems: Three Easy Pieces*, by Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau

Course Description

This course explores the design and implementation of computer operating systems. Topics include historical aspects of operating systems development, systems programming, process scheduling, synchronization of concurrent processes, virtual machines, memory management and virtual memory, I/O and file systems, system security, os/architecture interaction, and distributed operating systems. The concepts in this course are not limited to any particular operating system or hardware platform. We will discuss examples that are drawn from historically significant and modern operating systems including Unix, Windows, Mach, and the various generations of Mac OS.

The objective of this course is threefold: to demystify the interactions between the software you have written in other courses and hardware, to familiarize you with the issues involved in the design and implementation of modern operating systems, and to explain the more general systems principles that are used in the design of all computer systems.

Grading Details

Grades will be computed as follows:

- 5% Class Participation
- 10% Written Homework
- 50% Programming Projects
- 35% Exam(s)

Each of these items are explained in detail in the following sections.

Class Participation

Lectures are mandatory and you are expected to attend regularly. One goal of this course is to promote discussion of the issues in operating systems among all class members. As such, you

are encouraged to ask questions, point out weaknesses, and make observations during class. If you need to miss class for any reason, please let me know in advance.

━━━ Written Homework ━━━

The homework portion of your grade will be determined by short problems sets and/or written evaluations of a number of technical papers that we will read during the course of the semester. For each assigned paper, you will submit a 1-2 page evaluation that includes: (i) a high level summary that highlights the most important points addressed by the paper, (ii) the most glaring problem with the paper, and (iii) the conclusions you draw after reading the paper about building operating systems. Evaluations must be turned in on Glow before class on the day the paper is assigned. **Late homework will not receive credit for any reason.**

━━━ Programming Projects ━━━

There will be approximately 4 programming projects. Details will be available on the course webpage. The first project is simple, and is only meant to help you gain some experience with C++. The other projects will require a **substantial time commitment** on your part. However, you will be given approximately 2-3 weeks to complete each one. It is essential that you start the assignments early and not wait until the last minute! You will be penalized 25% for each day late.

To complete the projects in this course, you will need the ability to develop software programs using C/C++. If you have not used C/C++ recently (or at all), you may want to refresh your knowledge using one of the many good books on the topic. In particular I recommend the classic, The C Programming Language, by Kernighan and Ritchie, because it is short and simple. I have a few reference books in my office that you are welcome to use. There are also many online tutorials that Google can help you find. If you feel that need extra help, please come see me.

We will primarily use the Computer Science Department's Linux computers for the programming projects. If you are not familiar with the UNIX computing environment, talk to me as soon as possible so we can bring you up to speed on what you need to know.

━━━ Exam ━━━

There will be at least one written examination in this course. There will definitely be a midterm exam, and possibly a final exam as well. The exam(s) will be closed book, closed notes, and will stress conceptual understanding of the material. More details about the structure of the exams and required material will be discussed during class.

━━━ Collaboration ━━━

Homework assignments and examinations are to be completed individually. You are allowed to work in groups of 2 on programming assignments. I encourage collaboration and assistance in understanding course material (especially if you have limited experience with

C/C++), but not in developing solutions. Please be sure to give explicit credit for any help received. If you have any doubts about this, ask me whether or not collaboration is appropriate. Uncredited collaborations will be considered a violation of the honor code and will be handled appropriately. The computer science honor code and computer usage policy applies to all material in this class. If you are not familiar with this policy, please review `https://csci.williams.edu/the-cs-honor-code-and-computer-usage-policy/`.

━━━ Calendar ━━━

The following calendar is a (very) tentative schedule of topics that we will cover in class. This schedule will likely change, so you should check the course webpage frequently for an updated calendar and the associated reading assignments.

Date	Topic
Week 1	**Course Overview**
Week 2	**Processes, Threads, and Atomic Actions**
	Project 0 out. Paper: Lampson83.
Week 3	**Synchronization: Ordering and Locks**
	Project 0 due. Paper: Ritchie74.
Week 4	**Synchronization: Implementing Threads and Locks**
	Project 1 out.
Week 5	**Synchronization: Deadlock and CPU Scheduling**
	Project 1d due. Paper: Savage97.
Week 6	**Intro to Memory**
	Project 1t due.
Week 7	**Address Translation and Midterm**
	Midterm out.
Week 8	**Dual Mode Operation and Virtual Memory**
	Midterm due.
Week 9	**Virtual Machines and Containers**
	Project 2 out. Paper: Barham03.
Week 10	**Networks**
	Project 2 checkpoint due.
Week 11	**Security**
	Project 2 due. Paper: Banga99
Week 12	**Stack smashing and Files**
	Project 3 out. Paper: Rinard04
Week 13	**File Systems and Wrapup**
	Project 3 due during Exam period.