CS 471: Operating Systems

G. Exoo

Fall 2022

Course Description

An operating system (OS) is a set of software components that manage access to a computer's resources and provide services to users of these resources. Our goal will be to understand how an Operating System manages access to processors, to memory, to storage and other peripheral devices. We will focus on understanding process management, memory management, and file system organization on a modern computer.

Time	MWF 2:00PM
Room	Online (Zoom) and A-017 Root Hall
Professor	G. Exoo
Email	cs471@cs.indstate.edu
Office Hours	Online (Zoom): MWF 12:30–1:00 and MW 3:00–3:30
Class Web Page	http://cs.indstate.edu/cs471
Academic Integrity Policy	Student Guide
Online Textbook Links	How Linux Works, 2nd Edition Think OS: A Brief Introduction to Operating System The Little Book of Semaphores Other sites as listed on the class web page

Grading

Major projects	35%
Weekly programming assignments	35%
Quizzes	10%
Final Exam	10%
Attendance	10%

Course Outline:

- Introduction
  - The Kernel
    - What is it?
    - What does it do?
  - Monitoring the system
    - The /proc file system
    - The /sys file system
    - Utilities for monitoring the system: `ps`, `vmstat`, `df`, `ls`, etc.
- Computer Operating Systems
  - Memory Management
    - Historical overview

        * User space and kernel space
        * Memory organization in C
            · Text, data, heap, stack.
            · Executable file structure (ELF)
        * Virtual Memory
            · Paging
            · Logical addresses vs. physical addresses
            · Page tables
            · Page allocation
            · Address translation
        * Segmentation
        * Project examples: Buddy system, malloc library.
    - CPU Management
        * Processes
            · The life of a process
            · Creating processes
            · Managing processes
        * Threads
            · Synchronization
            · User threads
            · Kernel threads
        * Semaphores
        * Scheduling
        * Project example: comparison of scheduling algorithms using simulated process data.
    - Storage Management
        * File Systems
            · File system requirements
            · History of file systems
            · Examples
            · Directories, i-nodes, bit maps
            · One example file system with gorey details (e.g., *ext2*)
            · Project: implementing a filesystem
        * Devices
            · Generic device drivers
            · Graphics drivers

- Small Device Operating Systems
    - Unix based: iOS, Android
    - MSWindows based: ReactOS

Learning Outcomes

Upon successful completion of this course, students are expected to have the ability to

- Describe and explain the fundamental components of a computer operating system.
- Define, restate, discuss and explain the mechanisms used for process scheduling, memory management, and synchronization.
- Describe and explain the design and operation of one or more modern file systems.
- Design and construct computer programs that implement simplified versions of the following Operating System components: schedulers, memory management systems, file systems, and virtual memory and paging systems.
- Design and construct computer programs that implement important synchronization primitives using threads, semaphores, and threads.

Expected Amount of Work

If you take this class seriously and get what you should out of it, some weeks you will likely be spending an average of 15 hours/week or more on the class. The students who get A's in their CS courses and have an easy time finding jobs spend at least this much time. Not everyone will need to spend this much time and not all weeks will be the same, but you should plan on putting in whatever time it takes. Note - your classes should be more important than your part-time job.

Course Announcements

Announcements regarding the course will be made both during class, on the class web page, and to your cs email (which you should learn how to use). Communications related to grades will be sent to your @sycamores.indstate.edu email address. You should regularly check these locations.

Classroom Conduct

You may not use cell phones, iPods/music players, etc. during class. You should be civil and respectful to both the instructor and your classmates, and you should arrive to class a few minutes before the scheduled lecture so you are ready for lecture to begin on time. You may use your computer during class if you are using it to follow along with the examples that are being discussed. You may not check email, facebook, work on other courses, etc. during class.

Course Outline

The main topics in the course are listed below. This is intended as a topical outline, not a timeline. Database and Machine Learning concepts will be developed together. A dynamic timeline for the class can be found at the end of this document.

Assignments

The students in this course have the following responsibilities: read assigned readings before lecture, attend lecture, complete homework assignments, take in-class quizzes, take exams, and complete all projects. In this class, your final grade will be based primarily on the projects, and the lesser extent on the exams and quizzes.

Note that this course follows all standard CS course policies. In particular check the CS course policies related to - cheating/plagiarism, attendance, missing exams. Read the documents at each of the following links.

Class Web Page

CS457 on cs.indstate.edu

Polcies on Cheating, Plagiarism and Attendance

Academic Integrity

Academic Integrity Policy

Student Guide

All assignments are posted in a pdf file on the class web page. Each such file will indicate the number of points, the due date and time, and the location where your assignment should be saved. Failure to save your work in the correct location will be viewed as equivalent to not doing the work.

Late Assignments

The maximum points you will receive for late assignments will decay exponentially with time. If n is the number of points the assignment is worth, then a perfect assignment that is between $d-1$ and d days late will net at most $n/(2^d)$ points. We suggest attempting a homework assignment the day it is given, or the day after, so that if you do not understand how to do the assignment, you will have time to seek help. You may need to ask for help more than once, and you should certainly plan on spending a lot of time in the CS Lab (A-015 Root Hall or online). Many of the homework assignments require thought and creative problem solving. Do not expect to solve the problems the first time you attempt them.

Grading Policy

We try to design homework assignments and exams so that a standard cutoff for grades will be close to what you deserve. Grades are generally based on the following table.

A	93-100
A-	90-93
B+	87-90
B	83-87
B-	80-83
C+	77-80
C	73-77
C-	70-73
D+	67-70
D	63-67
D-	60-63
F	0-60

Grades are intended to indicate your mastery of the course material. The following are offered as guidelines.

A

You can do all the assignments on your own.

B+/A-

The student understands almost everything, and should be able to use this knowledge in other courses or in a job.

B-/B

The student understands most, but not all, topics well.

C/C+

Learned enough and have the minimum skills to move on in the subject.

D+/C-

The student made some effort in, and understands some things at a high level, but hasn't mastered the details well enough to be able to use this knowledge in the future.

D-

Students will normally not get an F if - they attend 80% of the lectures, complete some of the assignments up through the end of the course, and get nearly half of the problems on the final exam correct.

F

Normally, students that get an F simply stopped doing the required work at some point.

It's On BLUE.

Indiana State University fosters a campus free of sexual misconduct including sexual harassment, sexual violence, intimate partner violence, and stalking and/or any form of sex or gender discrimination. If you disclose a potential violation of the sexual misconduct policy I will need to notify the Title IX Coordinator. Students who have experienced sexual misconduct are encouraged to contact confidential resources listed below. To make a report to the Title IX Coordinator, visit the Equal Opportunity and Title IX website.

Confidential Resources:

The ISU Student Counseling Center
HMSU 7th Floor
812-237-3939.

Campus Ministries

For more information on your rights and available resources.

The required link on Covid-19.

The ISU Victim Advocate: Leah Reynolds

HMSU Room 813

812-237-3829 (office)

812-243-7272

`leah.reynolds@indstate.edu`