

# Operating Systems

## CS 421 - Fall 2023

**Instructor:** George Thomas **Office:** Halsey 218  
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**Office Hours:** MW 9:30-10:30  
 Tu 12:30-1:30  
 Th 11:30-12:30  
*Or by appointment*

**Lectures:** TuTh 9:40-11:10 Halsey 208

**Prerequisites:** A grade of C or better in CS 251 and CS 271

**Recommended Textbooks:**

- *Operating Systems: Principles and Practice*, Thomas Anderson and Michael Dahlin, 2nd edition, 2014, Recursive Books.
- *Operating Systems: Three Easy Pieces*, Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau. Available at <http://pages.cs.wisc.edu/~remzi/OSTEP/>

**Course Website:** UWO Canvas

**Current Catalog Course Description:**

An introduction to operating systems concepts. Topics covered include: interrupts, memory allocation, virtual memory techniques, process scheduling and synchronization, deadlocks, resource allocation, and file systems. A major programming project will be assigned to provide experience with operating system design.

**Course Outcomes:**

Outcomes #1: Overview

- 1a. Describe the objectives and functions of modern operating systems.
- 1b. Differentiate between the user and system views of the operating system.
- 1c. Explain the structure and mode of operations of modern operating systems as they relate to such concepts as multiprogramming, time-sharing, swapping, interrupt, and dual mode operation.
- 1d. Discuss the tradeoffs inherent in operating system design and identify potential threats and their safeguards in designed systems.

Outcomes #2: The Kernel

- 2a. Compare and contrast kernel mode versus user mode.
- 2b. Compare asynchronous and synchronous interrupts and describe the relative advantages of interrupts over polling.
- 2c. Discuss the system call concept and differentiate between the needs for the system call interface and the application program interface.
- 2d. Demonstrate how system programs manage the resources used by applications.

### Outcomes #3: The Processor

- 3a. Explain process state and process control blocks using appropriate examples to highlight their components.
- 3b. Describe the creation and termination, scheduling, and interprocess communication features of a process.
- 3c. Compare and contrast the various types of multithreading models and summarize the issues encountered with multithreaded programs (e.g., fork() and exec() system calls, cancellation, signal handling, thread pools, thread specific data, and scheduler activations)
- 3d. Compare and contrast the goals of parallel computing versus concurrency, and describe and analyze example problems in both paradigms.
- 3e. Identify the need for synchronization and atomicity, and describe problems arising from the concurrent operation of many separate tasks, including data races, safety and liveness failures, starvation and deadlocks.
- 3f. Explain how software and hardware are individually used to solve mutual exclusion problems, including the use of shared memory and synchronization primitives such as semaphores, locks and condition variables.
- 3g. Discuss the evaluation criteria for selecting a particular system's CPU scheduling algorithm and the various available criteria comparing CPU scheduling algorithms.

### Outcomes #4: Memory

- 4a. Compare and contrast paging and segmentation techniques.
- 4b. Evaluate the tradeoffs of the components in the memory hierarchy in terms of size, cost, and access time.
- 4c. Compare and contrast demand paging and copy on write techniques.
- 4d. Analyze such techniques or policies as page replacement, swapping, and thrashing.

### Outcomes #5: Persistent Storage

- 5a. Discuss file system design tradeoffs including access methods, file sharing, file locking, directory structures, and protection.
- 5b. Describe a file's attributes and operations.
- 5c. Describe and analyze the details of a local file system and directory structure implementation.

### Course Grading Policy:

Your final grade for this course will be based on three components, namely exams, programming projects and homework. Your overall numerical grade for the course will be computed as the weighted sum of the component grades using the following weights:

Component	Weight
Exams (3)	50%
Projects	30%
Homework	20%

Tentative exam dates are as follows:

- **Exam 1 - Thursday, 10/05**
- **Exam 2 - Thursday, 11/09**
- **Exam 3 - Thursday, 12/14**

Your letter grade for the course will be computed as follows:

Numerical Score	Grade	Numerical Score	Grade
>=92	A	72-78	C
90-92	A-	70-72	C-
88-90	B+	68-70	D+
82-88	B	62-68	D
80-82	B-	60-62	D-
78-80	C+	<60	F

While this overall grading scheme is fixed, I will be happy to discuss any issue you may have with individual grades. If you notice a mistake or have a question regarding a specific grade, please come and talk to me *as soon as possible*. Please do not wait until the end of the semester to bring up grading issues.

**Project and Homework Deadlines:**

Each homework will come with a deadline (day and time) by which it must be submitted. Late homework submissions will NOT be accepted.

Each project will also come with a deadline (day and time) by which it must be submitted. You are allotted *three* project credit days you can use through the semester. A credit day is exactly 24 hours or less. You can use unused credit days to submit a project after its deadline, without penalty. Any project submitted after the deadline, plus any credit days you have unused, will receive a zero.

For example, if you have 2 unused credit days available and a project is due on Tuesday at 5:00PM, you can submit it anytime by exactly Thursday at 5:00PM without penalty. Do note that if you submit your project on Thursday at 5:01PM, you will be penalized 100% of the score of the project and thus receive a zero! Note also that if you submit your project on Wednesday at 5:01PM, you will be charged two credit days (but no penalty, obviously).

**Attendance Policy:**

I do not require attendance for this course, but I do encourage you to attend and hope it will be beneficial to you. When attending class, please do come prepared for, and participate actively, in it. *Topics and material may be covered during the lectures that are not presented on Canvas. If you miss lecture, it is your responsibility to make sure you catch up on anything you may have missed!*

**Extensions and Makeups:**

Extensions on deadlines may be granted at the discretion of the instructor if you provide a valid justification (in the form of a written excuse from a medical doctor or the Dean of Students Office) **before** the due date.

If you miss a scheduled exam (tentative dates are provided), you **may** be able to take a make-up exam provided you give the instructor a valid justification (see above) ahead of time if possible. Only one make-up exam will be given. It will be a comprehensive exam scheduled at the end of the semester.

**Academic Misconduct Policy:**

Clearly, all exams and homework must be entirely your own work. Unless otherwise stated in a project, all submissions here must also be entirely your own work. While it is acceptable to discuss assignments at a high level (for example, at the design level) with

others, you must submit your own work. **You may not “borrow” any piece of code or design of any length from someone else, the internet, or any other source, unless you can live with a zero and the other potential academic sanctions of cheating** (see [UWO Student Discipline Code 2007](#), Chapter UWS 14).

**Use of AI tools in this class:**

As stated in the above section, I expect you to generate your own work in this class. When you submit any kind of work, you assert that you have generated any code and text yourself. Submitting content that has been generated by someone other than you or was created or assisted by a computer application or tool, including Artificial Intelligence (AI) will be considered cheating and will be subject to the Academic Misconduct policy.

**Accessibility and Accommodations:**

The University of Wisconsin Oshkosh supports the right of all enrolled students to a full and equal educational opportunity. It is the University’s policy to provide reasonable accommodations to students who have documented disabilities that may affect their ability to participate in course activities or to meet course requirements. Students are expected to inform instructors of the need for accommodations as soon as possible by presenting an Accommodation Plan from either the Accessibility Center, Project Success, or both. Reasonable accommodations for students with disabilities is a shared instructor and student responsibility. The Accessibility Center is part of the Dean of Students Office and is located in 125 Dempsey Hall. For more information, email [accessibilitycenter@uwosh.edu](mailto:accessibilitycenter@uwosh.edu), call 920-424-3100, or visit the Accessibility Center Website.

**Equity & Inclusion:**

At the University of Wisconsin Oshkosh, the culture, identities, life experiences, unique abilities, and talents of every individual contribute to the foundation of our success. Creating and maintaining an inclusive and equitable environment is of paramount importance to us. This pursuit prepares all of us to be global citizens who will contribute to the betterment of the world. We are committed to a university culture that provides everyone with the opportunity to thrive.

**Disclosure Statement:**

Students are advised to see the following URL for disclosures about essential consumer protection items required by the Students Right to Know Act of 1990:  
<https://uwosh.edu/financialaid/consumer-information/>