Carleton UNIVERSITY | Department of Systems and Computer Engineering

SYSC 4001
Operating Systems
Fall 2024

Instructor

Prof. Gabriel A. Wainer

sysc-4001@carleton.ca

VS 3126

Office Hours and TA information available on Brightspace

This course outline is intended to provide students with guidelines for the course. It is important to understand that the final determination on all matters related to the Course Outline will be made in class, and if there is a conflict between this document and what is discussed in class, the latter takes precedence. Updates to this document will be posted on Brightspace, but students are responsible for knowing and adhering to the rules established in class. If a student misses a class, they must inform themselves of what was discussed by consulting with teaching assistants or classmates and confirming with the instructor. This approach encourages accountability and fosters a collaborative learning environment.

Class Rules:

- No electronic devices are allowed during class. Cell phones, tablets, laptops and other electronic devices are forbidden.
- Exceptions: note takers or PMC students with proper authorization. Authorized students should identify themselves with the Instructor, and coordinate in order to disturbing the class.
- Students arriving late to class should wait for permission before entering the classroom.

Course Description and requirements

1) Course description

Introduction to operating system principles. Processes and threads. CPU scheduling. Managing concurrency: mutual exclusion and synchronization, deadlock and starvation. Managing memory and input/output. Concurrent programming, including interprocess communication in distributed systems.

Includes: Experiential Learning Activity.

Lectures three hours a week, laboratory three hours a week.

http://calendar.carleton.ca/undergrad/courses/SYSC/

2) Prerequisites

SYSC 2006 with a minimum grade of C-.

Precludes additional credit for SYSC 3001 and COMP 3000.

3) Prior Knowledge

Students should have:

- Good knowledge of programming (including programming in C).
- Knowledge of data structures.
- Basic knowledge of processor architecture.

4) Course Objectives

The objective of this course is to expose the students to the fundamental concepts underlying operating systems. The topics will include the management of both software processes and hard ware devices in a computer system. Students will learn techniques for handling concurrent processes including different synchronization and inter-process communication techniques. Various device management techniques including CPU and I/O scheduling as well as techniques for managing memory including virtual memory systems will be discussed. The course will also include a discussion of different file system management techniques.

5) Accreditation Units

For more information about Accreditation Units, please visit:

https://engineerscanada.ca/.

The course has 55 AUs divided into:

Math	Natural Science	Complementary Studies	Engineering Science	Engineering Design
			75%	25%

6) Learning outcomes / Graduate Attributes

By the end of this course, students should be able to:

- Understand the basic concepts and techniques underlying concurrent processing.
- Design and implement systems with concurrent processes and handle inter-process communication, synchronization and mutual exclusion.
- Understand the various techniques and algorithms for memory management.
- Know the various operating system components (hardware and software) related to virtual memory management.
- Know the popular CPU scheduling policies and be able to understand their performance implications.
- Know various disk I/O scheduling policies and how to evaluate them.
- Understand file system management techniques.
- Know about comparative analysis of various operating systems algorithms.
- Know about tools for system design and analysis.

The Canadian Engineering Accreditation Board requires graduates of undergraduate engineering programs to possess 12 attributes. Courses in all four years of our programs evaluate students' progress towards acquiring these attributes. Aggregate data (typically, the data collected in all sections of a course during an academic year) is used for accreditation purposes and to guide improvements to our programs. Some of the assessments used to measure GAs may also contribute to final grades; however, the GA measurements for individual students are not used to determine the student's year-to-year progression through the program or eligibility to graduate.

This following list provides the GAs that will be measured in this course, along with the learning outcomes that are intended to develop abilities related to these attributes.

GA - Indicator	Assessment Tool
1.4.S: Knowledge Base: Developed: Programming and algorithms	1, 2
1.5.S: Knowledge Base: Developed: Computer systems	1, 3-7
3.3: Investigation: Introduced: Experimental procedure	8
3.5: Investigation: Introduced: Interpretation of data (synthesis) and discussion	8
4.1: Design: Introduced: Clear design goals	2
4.5: Design: Developed: Design implementation / task(s) definition	2
5.3: Use of Engineering Tools: Applied: Tools for design, experimentation, simulation, visualization, and analysis	9

7) Texts

Operating System Concepts (7th Edition or higher), by Silberschatz, Galvin and Gagne, John Wiley & Sons Inc. (other textbooks might be good too; consult with Prof. Wainer)

Reference: Beginning Linux Programming, 3rd ed., by Richard Stones and Neil Matthew, Wrox Press Ltd**. The book is optional because most of the related materials can be found online; information for the programming assignments will be available on the course webpage.**

8) List of Topics

- Processes and Threads
- Management of Concurrent Processes
- CPU Scheduling
- Deadlock Handling
- Memory Management
- Disk Scheduling
- File System Management

9) Course Schedule

The course is structured to enhance students' understanding of critical topics in operating systems and concurrent computing through a combination of theoretical and practical programming assignments. Each assignment will include conceptual questions that will require students to analyze and elaborate on the topics discussed in class. This integration of theory and practice aims to solidify students' comprehension and application of concepts such as CPU scheduling techniques, memory management strategies, processes and their life cycles, inter-process communications, multithreading, and the principles behind client/server architectures.

Lectures will be delivered **in person**. Lectures will not be streamed or recorded.

Tentative week-by-week breakdown

Although we intend to follow this week-by-week outline, divergence from the outline may occur:

1. Introduction
2. Operating system overview
3. Processes and Threads. Multiprogramming, Timesharing systems, Systems Calls, Protection in OS. Process description and control
4. CPU Scheduling
5. Concurrency: mutual exclusion and synchronization. Semaphores. Critical sections.
6. Concurrency: deadlock and starvation.
7. Memory management **MIDTERM (October 15th, during the scheduled lecture)**
8. Virtual memory
9. Virtual Memory
10. File management
11. File Management
12. I/O management and disk scheduling
13. Review and wrap-up

10) Evaluation and Marking Scheme

10.1. General aspects

Students will complete three assignments using the Linux operating system in C or C++. These assignments are designed to provide hands-on experience, encouraging students to engage with the material. Individual coursework is mandatory; a fundamental part of the course evaluation is the student’s work, and students are expected to complete the coursework in order to succeed in learning. Detailed instructions will be provided on each assignment.

Laboratory Sessions: we have an Open Lab policy. You only attend your lab sessions (those you selected on Carleton Central) and at that time the TAs will be available to

discuss the questions and programming components of each of the assignments during the lab hours. Students must submit their assignments to Brightspace before the deadline.

Additionally, there will be a mid-term and a Final exam, which will assess the students' understanding of course contents and their ability to apply engineering design principles. This includes evaluating various design alternatives and solutions proposed by students within their assignments. Critical thinking is a crucial component of all the course components and will be evaluated at every stage of the course.

10.2. Evaluations

Students evaluations are divided into two parts: (a) Coursework, and (b) a Final Exam.

Coursework: 50 points, composed of:

- **Assignments: 30 points (3 assignments of 10 points each)**
- **Mid-term exam: 20 points**

Final Exam: 50 points

To pass the course (i.e., D- or higher), students must pass the Coursework (i.e., achieve a score of 25/50), and obtain a minimum score of 60% (i.e., 30/50) in the Final. In other words:

i. **Coursework**: a score below 25/50 points in the Coursework (midterm + assignments) results in an F grade, independently of the mark in the Final Exam (including deferred Final examinations).

ii. **Final Exam**: a score below 60% (30/50 points) will result in an F grade, independent of the mark in the Coursework.

These rules are summarized in the table at the end of section 10.3. The total of the marks will be converted to a letter grade (using the table of percentage equivalents shown in the *Undergraduate Calendar, Academic Regulations of the University, Section 5.4, Grading System)* as long as the student meets the Evaluations rules; otherwise, the student's grade will be an F.

Important rules on evaluations:

Requests to increase the weight of any course components (in particular, the final exam) because of poor performance will not be considered.

- Engineering Courses shall have on-campus and proctored final examinations.

- Final exams are for evaluation purpose and will not be returned to students.

- Both the mid-term and the final exams will be closed-book, and **no calculators** will be allowed; the exams will focus on mastering the content covered during the course. The midterm and final exams will be held in person on Campus. Exams will be written on paper. Each exam will cover all the materials taught in class. You will be expected to complete the exams on your own, without any support from or communication with others.

10.3. Missed Term Work and Deferrals

a) Students who encounter short-term extenuating circumstances (typically lasting up to five days) and are unable to complete term work must promptly notify the instructor by submitting a completed self-declaration form. This notification must occur no later than three (3) days after the deadline of the term work. Furthermore, any alternate arrangements should be finalized before the last day of classes for the term as outlined in the academic schedule. For further details, please refer to Section 4.4 of the University Calendar:

https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/examinations/#deferred-term-work

b) No extensions or deferrals will be granted for assignments. Assignments are provided ahead of their deadlines, giving students plenty of time to solve them. This allows for effective planning, seeking help, and understanding the content without the stress of tight deadlines. Assignments submitted after the deadline will receive a mark of zero (0). Deadlines are hard and will not be extended. It is recommended that the students submit partial versions of their assignments, which will be used for evaluation in case of short-term extenuating circumstances (read rule a) above).

c) If a student defers the midterm, and has, at least, 20/30 points in their Assignments, the midterm mark will be calculated as a weighted average of the other marks in the term, as follows:

- A 70% of the Final Exam mark.
- A 30% of the Assignments mark.

d) Students who are unable to take the final examination because of a serious illness/emergency or other circumstance beyond their control may apply for accommodation by contacting the Registrar's office. Consult the Section 4.3 of the University Calendar

(https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/examinations/)

e) Students who are approved for a deferred final exam by the Registrar's office, they must also have achieved above 10/20 points in their Midterm Examination and, at least,

20/30 points in their Assignments to pass the course. If a student defers the midterm, the grade in the midterm will be considered 0/20. Thus, the final grade for students deferring both the midterm and the final exam will be an F, regardless of their grade on the deferred exam.

f) The tables below summarizes all the different potential cases discussed in this section.

Table 1: Non-deferred cases

Total Coursework (Max: 50)	Final (Max: 50)	Total Mark
>= 25 (PASS)	>=30 (PASS)	Coursework + Final
< 25 (FAIL)	Any grade	F
>= 25 (PASS)	<30 (FAIL)	F

Table 2 – Deferred cases

Assignments (Max: 30)	Midterm (Max: 20)	**Total Coursework (Max: 50)**	Final (Max: 50)	Total Mark
>= 20	>= 10	**>= 20+10 (PASS)**	>=30 (PASS) **(Deferred Final)**	Coursework + Final
>= 20	Deferred	**>= 20 (PASS)**	>=30 (PASS) **(Non-Deferred Final)**	Assignments + Final + Calculated midterm grade (30% Assignments + 70% Final)
< 20	< 10	Any total	Any grade **(Deferred Final)**	F
< 20	Deferred	**< 20 (FAIL)**	Any grade **(Non-Deferred Final)**	F
Any grade	Deferred	Any grade	Any grade **(Deferred Final)**	F

g) Additional requirement(s):

Please consult Section 5 of the undergraduate regulations (https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/grading/)

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Advising and Counselling services

a) Engineering Academic Advising

The Engineering Academic Support Service : https://carleton.ca/engineering-design/current-students/undergrad-academic-support/ assists undergraduate engineering students with course selection, registration, and learning support from first-year through to graduation.

Academic Advisors Contact : https://carleton.ca/engineering-design/current-students/undergrad-academic-support/undergraduate-advisors/

b) Student Mental Health Service

As a University student you may experience a range of mental health challenges that significantly impact your academic success and overall well-being. Carleton's Wellness Services Navigator https://wellness.carleton.ca/navigator/ is designed to help students connect with mental health and wellness resources. If you need to talk to someone, please reach out for assistance: https://carleton.ca/health/emergencies-and-crisis/.

Learning and Working Environment

The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the Department of Equity and Inclusive Communities at equity@carleton.ca

We will strive to create an environment of mutual respect for all through equity, diversity, and inclusion within this course. The space which we work in will be safe for everyone. Please be considerate of everyone's personal beliefs, choices, and opinions.

Academic Integrity and Plagiarism

a) Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures: https://carleton.ca/engineering-design/current-students/fed-academic-integrity. Violations of the Academic Integrity

Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or, expulsion.

b) One of the main objectives of the Academic Integrity Policy is to ensure that the work you submit is your own. As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as “presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one’s own.” This includes reproducing or paraphrasing portions of someone else’s published or unpublished material, regardless of the source, and presenting these as one’s own without proper citation or reference to the original source.

Examples of violations of the policy include, but are not limited to:
· any submission prepared in whole or in part, by someone else;

· using another’s data or research findings without appropriate acknowledgement;

· submitting a computer program developed in whole or in part by someone else, with or without modifications, as one’s own;

· failing to acknowledge sources of information through the use of proper citations when using another’s work and/or failing to use quotations marks; and

· unless explicitly permitted by the instructor in a specific course, the use of generative AI and similar tools to produce assessed content (such as text, code, equations, images, summaries, videos, etc.).

Academic Accommodations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For accommodation regarding a formally-scheduled final exam, you must complete the Pregnancy Accommodation Form (click here).

Religious obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details click here.

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic

medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made.

You should request your academic accommodations in the Ventus Student Portal, for each course at the beginning of every term. For in-term tests or midterms, please request accommodations at least two (2) weeks before the first test or midterm.

Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).

Survivors of Sexual Violence: As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/equity/sexual-assault-support-services.

Accommodation for Student Activities: Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation will be provided to students who compete or perform at the national or international level. Write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf