UNIVERSITY of GUELPH

ENGG*4540 - Advanced Computer Architecture
Winter 2026 Course Outline
Section: 01
Credits: 0.50

Land Acknowledgement: Guelph

The University of Guelph resides on the ancestral lands of the Attawandaron people and the treaty lands and territory of the Mississaugas of the Credit. We recognize the significance of the Dish with One Spoon Covenant to this land and offer respect to our Anishinaabe, Haudenosaunee and Métis neighbours. Today, this gathering place is home to many First Nations, Inuit, and Métis peoples and acknowledging them reminds us of our important connection to this land where we work and learn**.**

Calendar Description

This course covers topics such as: basics of pipeline structure, advanced pipelining and instruction level parallelism, multiprocessor and thread-level parallelism, memory-hierarchy design (main memory, virtual memory, caches), storage systems, interconnection networks, multiprocessor architectures (centralized and distributed). Advanced topics related to new emerging computer architectures will also be presented. The emphasis in each topic is on fundamental limitations and the trade-offs involved in designing computer systems, including memory and processing bandwidth, network bandwidth and latency, synchronization, and storage system bandwidth and latency.
Prerequisite(s): ENGG*3380
Restriction(s): Non-BENG students may take a maximum of 4.00 ENGG credits.
Department(s): School of Engineering

Course Description

The aim of this course is to familiarize students with the basic principles of computer architecture and design, with an emphasis on cost-performance-energy trade-offs, good engineering design, and a focus on quantitative analysis of real systems.

Course Fit Within Program/Curriculum

Previous Course: ENGG*3380: discussed fundamentals of computer architecture. This course builds on this information by providing advanced topics in computer architecture.

Lecture Schedule

TuTh 2:30pm-3:50pm in GRHM*2310 (1/5 to 4/21)

TuTh 2:30pm-3:50pm in GRHM*2310 (1/2 to 4/28)

Lab / Seminar Schedule

Day	Time	Location	Sections
Monday	11:30 AM - 1:20 PM	RICH 2531	01
Monday	2:30 PM - 4:20 PM	RICH 2531	02
Wednesday	12:30 PM - 2:20 PM	RICH 2531	03

Instructor Information

Textbooks

Group	Title	Author	ISBN
Required	Computer Architecture: A Quantitative Approach	John L. Hennessy and David A. Patterson	9780128119068
Recommended	Computer Organization and Design MIPS Edition: The Hardware/ Software Interface	David A. Patterson and John L. Hennessy	9780128226742

Learning Resources

Course Website (Website)
- Course material, news, announcements, and grades will be regularly posted to the ENGG*4540 CourseLink. You are responsible for checking the site regularly.

Additional Resources (Other)
- Lecture Information: Selected lecture notes are posted on the ENGG*4540 CourseLink system
- William Stallings, Computer Organization and Architecture, 11th Edition by Pearson, 2019 Lab Information: The Lab Manual will be posted on the ENGG*4540 CourseLink system.
- **Campus Resources**

  If you are concerned about any aspect of your academic program: Make an appointment with a Program Counsellor (https://www.uoguelph.ca/uaic/programcounsellors/) in your degree program. If you are struggling to succeed academically: There are numerous academic resources offered by the Learning Commons (https://www.lib.uoguelph.ca/using-library/spaces/learning-commons/) including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills.

Cost of Textbooks and Learning Resources

Textbook / Learning Resource	Required / Recommended	Cost
Computer Architecture: A Quantitative Approach (Textbook)	Required	65.24

Students are advised that prices are often determined by the publisher or bookstore and may be subject to change.

Library Course Reserve (Ares)

For this course, you will be required to access course reserve materials through the University of Guelph McLaughlin Library. To access these items, select **Ares** on the navbar in CourseLink. Note that you will need your Central Login ID and password in order to access items on reserve.
For further instructions on accessing reserve resources, visit How to Get Course Reserve Materials (https://www.lib.uoguelph.ca/find/course-reserves-ares/).
If at any point during the course you have difficulty accessing reserve materials, please contact the e-Learning Operations and Reserve Services staff at:
Tel: 519-824-4120 ext. 53621 | Email: libres2@uoguelph.ca | Location: McLaughlin Library, First Floor, University of Guelph

Course Learning Outcomes

1. Identify the tasks involved in computer architecture design, with trends in technology, usage, and cost
2. Measure and report performance of computer architectures
3. Classify instruction set architectures, and comprehend the instruction formats and semantics
4. Identify and analyze basic pipeline operations, data and control pipeline hazards, and instruction- level parallelism
5. Communicate effectively about advanced computer architectures and memory-hierarchy design, including cache design issues and modern multicore architectures
6. Experiment with computer architecture simulators to investigate different design choices and study the impact of each of these choices.

Schedule of Topics and Assignments

Week of	Topic	Activities	Due
1/6	Introduction and Evaluating computer systems		
1/13	Power, reliability, cost, performance		
1/20	Benchmarks, pipelining intro		
1/27	Pipelining Basics		
2/3	Pipelining hazards		
2/10	Control hazards, advanced pipelines		
2/17		Winter Break	
2/19		Winter Break	
2/24	Compiler-based (static) ILP, loop optimizations.		
3/3	Branch Prediction		
3/10	Out-of-order processors		
3/17	Cache basics and innovations.		
3/24	Extra Topics + Projects Presentations		
3/31	Extra Topics + Projects Presentations		

Lab / Seminar Schedule

Topics: Lab 1: lmbench - Benchmark

Topics: Lab 2: Introduction to MARS and MIPS (/ RISC-V Introduction — Multi-Cycle and Two-Stage Pipeline)

Topics: Lab 3: More on MIPS -Instruction Pipelining (/ RISC-V Processor with Six-Stage Pipeline and Branch Prediction)

Topics: Lab 4: RISC-V Processor with DRAM and Caches

Topics: Lab 5: Conditional Execution and Procedures

Teaching and Learning Activities

Topics: Introduction and Evaluating computer systems

Topics: Power, reliability, cost, performance

Topics: Benchmarks, pipelining intro

Topics: Pipelining Basics

Topics: Pipelining hazards

Topics: Control hazards, advanced pipelines

Topics: Compiler-based (static) ILP, loop optimizations.

Topics: Branch Prediction

Topics: Out-of-order processors

Topics: Cache basics and innovations.

Topics: Extra Topics

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Please note that lecture topics and orders are subject to changes.

All updated information will be posted regularly on the course webpage.

Assessment Breakdown

Description	Weighting (%)	Due Date
Labs	25%	As per the Lab Schedule
Final Project	35%	Weeks 10-12
Midterm	15%	Week 8
Final Exam	25%	April 18, 2026

Assessment Details

Lab Activities
Labs   **25**
Labs are equal weight

Course Learning Outcomes Assessed: 1, 2, 3, 4, 5, 6

Exam
Midterm   **15**
Week 8 - In Class

Course Learning Outcomes Assessed: 1, 3, 4, 5

Final Exam   **25**
April 18th, 2026 - 8:30 am - 10:30 am

Course Learning Outcomes Assessed: 1, 3, 4, 5

Project
Project   **35**
Include: Midterm Report - Final Term Paper - Presentation

Course Learning Outcomes Assessed: 1, 2, 3, 4, 5, 6

Final Exam

Date: Apr 18

Time: Sa 8:30am-10:30am

Location: TBA *Please see Web Advisor closer to the date of scheduled final for location.*

To understand rules and regulations regarding Examinations students are encouraged to read Student's Responsibilities (https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/examinations/)

If the student is unable to meet the final exam requirements due to medical, psychological or compassionate circumstances they are encouraged to review Student's Responsibilities in the Academic Consideration, Appeals and Petitions (https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-consideration-appeals-petitions/) section of the Academic Calendar.

Last Day to Drop Course

The final day to drop Winter 2026 courses without academic penalty is the last day of classes: April 06

After this date, a mark will be recorded, whether course work is completed or not (a zero is assigned for missed tests/assignments). This mark will show on the student's transcript and will be calculated into their average.

Course Grading Policies

Missed Assessments

If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of Religious Obligations:

If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor at the start of the semester (during week 1) to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Course Standard Statements

Course Policies

Passing grade: In order to pass the course, you must meet the following conditions:

1. Students must finalize and submit all the labs and projects (Demo + Report) and obtain a passing grade of 50% or higher in all the labs and projects. If an overall grade of lower than 50% is obtained in any lab, the students need to arrange with the instructor a new demo and report submission. In this case, a grade penalty of 10% deduction will be applied.
2. Students must write both exams (midterm and final) to pass the course. If the student misses the midterm exam (with an acceptable excuse as per the university guidelines), The weight of the missed Midterm will be **reallocated to the Final Exam**. No separate makeup Midterm will be scheduled.

Contesting Marks: All laboratory and midterm exam marks must be contested within 2 days from grade submission.

Missed midterm exam: If you miss a test due to grounds for granting academic consideration or religious accommodation,**no documentation is required**. The weight of the missed Midterm will be **reallocated to the Final Exam**. No separate makeup Midterm will be scheduled.

Lab work: You must attend and complete all laboratories. If you miss a laboratory demo due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the GTA to complete a makeup lab demo.

Late Lab Reports: Late submissions of lab reports will be accepted only with the approval of the course instructor. However, penalties for late submissions will be applied. Applied penalties will be posted on the ENGG*4540 CourseLink system.

Late Assessment Submission: Late submissions of assignments or activities will be penalized 10% deduction per day.

School of Engineering Statements

Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on
Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible

Standard Statements for Undergraduate Courses

Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy (https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-misconduct/) is outlined in the Undergraduate Calendar.

Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability. Use of the SAS Exam Centre requires students to make a booking at least 10 days in advance, and no later than the first business day in November, March or July as appropriate for the semester. Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time. For students at the Guelph campus, information can be found on the SAS website. (https://www.uoguelph.ca/sas/)

Accommodation of Religious Obligations

If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements.

See the Academic calendar for information on regulations and procedures for Academic Accommodations of Religious Obligations (https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-accommodation-religious-obligations/).

Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all undergraduate students except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in the Undergraduate Calendar - Dropping Courses (https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/dropping-courses/).

Email Communication

As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

Health and Wellbeing

The University of Guelph provides a wide range of health and wellbeing services at the Vaccarino Centre for Student Wellness (https://wellness.uoguelph.ca/). If you are concerned about your mental health and not sure where to start, connect with a Student Wellness Navigator (https://wellness.uoguelph.ca/navigators/) who can help develop a plan to manage and support your mental health or check out our mental wellbeing resources (https://wellness.uoguelph.ca/shine-this-year/). The Student Wellness team are here to help and welcome the opportunity to connect with you.

Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g., final exam or major assignment).

Recording of Materials

Presentations that are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Resources

The Academic Calendars (http://www.uoguelph.ca/registrar/calendars/?index) are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.

When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. See the Undergraduate Calendar for information on regulations and procedures for Academic Consideration. (https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-consideration-appeals-petitions/)

Professional Accreditation Outcomes

Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

1. Knowledge Base

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
1.4	Recall, describe and apply program-specific engineering principles and concepts	Advanced	No

2. Problem Analysis

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
2.1	Formulate a problem statement in engineering and non-engineering terminology	Advanced	No
2.2	Identify, organize and justify appropriate information, including assumptions	Advanced	Yes
2.3	Construct a conceptual framework and select an appropriate solution approach	Advanced	Yes
2.5	Critique and appraise solution approach and results	Advanced	No

3. Investigation

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
3.3	Analyze and interpret experimental data	Advanced	Yes

5. Use of Engineering Tools

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
5.2	Demonstrate proficiency in the application of selected engineering tools	Advanced	No

7. Communication Skills

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	Developed	No
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	Advanced	No
7.4	Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references	Advanced	No