

CS 241E: Foundations of Sequential Programs (Enriched)

Fall 2020

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Lectures, tutorials, office hours: The primary delivery method of lecture material will be **written notes**, which will be posted weekly on Learn and on Piazza. There will be live and recorded **online tutorials** on Learn, generally twice a week, to enable interactive questions and discussion of the lecture material and assignments. Questions and discussion will also take place in written form on **Piazza**. There will be **office hours** on MS Teams for individual questions. The dates and times of tutorials and office hours will be determined by a poll of students on Piazza and will be announced on Piazza and Learn.

Objective: To describe the relationship between high-level programming languages and the computer architecture that underlies their implementation.

Prerequisites: (85% in CS 146) or (85% in CS 136) or (85% in CS 138); Computer Science students only.

Antirequisites: CS 230, GENE 344

Non-enriched version: Any CS 241E student may switch to the regular version of CS 241 during the **first two weeks** of lectures. Please see the CS undergraduate advisors to do so.

Website: <http://www.student.cs.uwaterloo.ca/~cs241e>. Assignment specifications and other course resources can be found here.

Discussion Forum: <https://piazza.com/uwaterloo.ca/fall2020/cs241e>. In the absence of in-person meetings, be sure to check Piazza frequently for essential announcements and questions and discussion of the course material.

Course Description: The relationship between high-level languages and the computer architecture that underlies their implementation, including basic machine architecture, assemblers, specification and translation of programming languages, linkers and loaders, block-structured languages, parameter passing mechanisms, and comparison of programming languages.

Course Overview:

Machine architecture and assembly language (6 hours)

Functional components of a computer: memory, control unit, arithmetic/logic unit, input/output devices. Data representation. Machine language: operation codes, addressing modes, indexing, base registers, register designation. Assemblers. Linking and Loading.

Machine-level implementation of high-level language features (9 hours)

Variables and data representation, control structures, procedures and procedure calls, scopes and nesting, closures and objects.

Regular languages and scanning (5 hours)

Architecture of a compiler. Syntax vs. semantics. Introduction to formal languages. Regular languages, regular expressions and finite state machines.

Context-free languages and parsing (5 hours)

Context-free grammars, derivations, derivation trees, ambiguous grammars. Parsing algorithms.

Semantic Analysis and Code generation (6 hours)

Parse trees, name resolution, type-checking, code generation.

Memory Management (5 hours)

Implications of stack versus heap allocation. Dynamic Memory Allocation. Automatic Garbage Collection.

Assignments: There will be twelve assignments. Real-time feedback on the correctness of your solutions is provided by the Marmoset submission and testing server. All assignments must be submitted electronically to Marmoset and results are normally quickly available. We recommend that you work on assignments early. Use Marmoset to assess your progress (and grade!) after convincing yourself of correctness using

your own self-designed tests. By the time you submit to Marmoset, you should be convinced by your own thorough testing that your program is perfect. A link to the Marmoset system and instructions for using it may be found on the course web page.

Late policy: To receive full credit, a submission *must* be received before the due date/time of the assignment. For every assignment except Assignment 11, a submission received up to one week late will receive partial credit calculated as 75% of the grade on the late submission plus 25% of the grade on your best on-time submission for the same assignment.

Exams: There will be no midterm or final exam.

Grade Calculation: Each of the 12 assignments is worth $8\frac{1}{3}\%$ of the final grade, for a total of 100%.

Academic Offenses: Students are expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for their actions. Students who are unsure whether an action constitutes an offense, or who need help in learning how to avoid offenses (e.g., plagiarism, cheating) or about rules for group work/collaboration should seek guidance from the instructor, ISC, ISA, or the Undergraduate Associate Dean.

All assignments in CS241E are to be done individually. You are welcome to discuss general ideas regarding assignments with other students in the class, but no code-level sharing is permitted. You may not look at someone else's code, nor share your code with someone else, either in person or via electronic communication (e.g., instant messaging, discussion forum). When code is shared, **both** parties are considered to have committed an offence. Marmoset tokens cannot be shared; it is an offence to "borrow" someone else's Marmoset account for the purpose of using extra release tokens for testing, or for any other purpose. It is an offence to submit for credit anything that has previously been submitted for credit in the same or any other course, unless permission is explicitly granted to do so. The penalty for an offence under Policy 71 is a grade of 0 on the assignment and an *additional* 5% deduction from your course grade.

Discipline cases involving any automated or partially automated marking system such as Marmoset and MarkUs include, but are not limited to, printing or returning values in order to match expected test results rather than making an actual reasonable attempt to solve the problem as required in the assignment question specification.

Use of MOSS: MOSS (Measure of Software Similarities) is used in CS 241E as a means of comparing students' assignments in order to support academic integrity.

Course Schedule: A course outline follows. Note that the assignment of topics to weeks is our current best guess as to what will be covered when. Assignment due dates are subject to change as dictated by the pace of the course.

Week	Dates	Topics	Notes
I	Sept 8–11	Introduction	
II	Sept 14–18	Machine language, assembly language	Assignment 1 due Fri Sept 18
III	Sept 21–25	Assemblers, variables	Assignment 2 due Fri Sept 25
IV	Sept 28–Oct 2	Stacks, expressions, control structures	Assignment 3 due Fri Oct 2
V	Oct 5–9	Procedures and calls	Assignment 4 due Fri Oct 9
VI	Oct 19-23	Scopes, closures, objects	Assignment 5 due Fri Oct 23
VII	Oct 26–30	Regular languages, scanning	Assignment 6A due Fri Oct 30
VIII	Nov 2–6	Context-free languages, parsing	Assignment 7 due Fri Nov 6
IX	Nov 9–13	Context-sensitive analysis	Assignment 8 due Fri Nov 13
X	Nov 16–20	Code generation	Assignment 9 due Fri Nov 20
XI	Nov 23–27	Memory management	Assignments 6B and 10 due Fri Nov 27
XII	Nov 30–Dec 7	Memory management, conclusion	Assignment 11 due Fri Dec 4

Intellectual Property: Students should be aware that this course contains the intellectual property of their instructor, TA, and/or the University of Waterloo. Intellectual property includes items such as:

- Lecture content, spoken and written (and any audio/video recording thereof);
- Lecture handouts, presentations, and other materials prepared for the course (e.g., PowerPoint slides);
- Questions or solution sets from various types of assessments (e.g., assignments, quizzes, tests, final exams); and
- Work protected by copyright (e.g., any work authored by the instructor or TA or used by the instructor or TA with permission of the copyright owner).

Course materials and the intellectual property contained therein, are used to enhance a student's educational experience. However, sharing this intellectual property without the intellectual property owner's permission is a violation of intellectual property rights. For this reason, it is necessary to ask the instructor, TA and/or the University of Waterloo for permission before uploading and sharing the intellectual property of others online (e.g., to an online repository). Permission from an instructor, TA or the University is also necessary before sharing the intellectual property of others from completed courses with students taking the same/similar courses in subsequent terms/years. In many cases, instructors might be happy to allow distribution of certain materials. However, doing so without expressed permission is considered a violation of intellectual property rights.

Please alert the instructor if you become aware of intellectual property belonging to others (past or present) circulating, either through the student body or online. The intellectual property rights owner deserves to know (and may have already given their consent).

Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check the Office of Academic Integrity for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions. [Check the Office of Academic Integrity for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals.

Note for students with disabilities: AccessAbility Services, located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

Mental Health: If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support.

- On-campus Resources
 - Campus Wellness <https://uwaterloo.ca/campus-wellness/>
 - Counselling Services: counselling.services@uwaterloo.ca / 519-888-4567 ext 32655 / Needles Hall North 2nd floor, (NH 2401)
 - MATES: one-to-one peer support program offered by Federation of Students (FEDS) and Counselling Services: mates@uwaterloo.ca

- Health Services service: located across the creek from Student Life Centre, 519-888-4096.
- Off-campus Resources
 - Good2Talk (24/7): Free confidential help line for post-secondary students. Phone: 1-866-925-5454
 - Here 24/7: Mental Health and Crisis Service Team. Phone: 1-844-437-3247
 - OK2BME: set of support services for lesbian, gay, bisexual, transgender or questioning teens in Waterloo. Phone: 519-884-0000 extension 213

Diversity: It is our intent that students from all diverse backgrounds and perspectives be well served by this course, and that students' learning needs be addressed both in and out of class. We recognize the immense value of the diversity in identities, perspectives, and contributions that students bring, and the benefit it has on our educational environment. Your suggestions are encouraged and appreciated. Please let us know ways to improve the effectiveness of the course for you personally or for other students or student groups. In particular:

- We will gladly honour your request to address you by an alternate/preferred name or gender pronoun. Please advise us of this preference early in the semester so we may make appropriate changes to our records.
- We will honour your religious holidays and celebrations. Please inform of us these at the start of the course.
- We will follow AccessAbility Services guidelines and protocols on how to best support students with different learning needs.