CS 330: FORMAL METHODS AND MODELS
SECTION 001 — FALL 2024

Instructor Information

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Class Information

Dates: August 26 – December 18
Time: Mon/Wed 9:00 AM– 10:15 AM
Classroom: Horizon Hall 2008
Prerequisites: CS 211 and MATH 125 (C or better in both)
Communication: Piazza
LMS: Blackboard
Textbook: Hamburger and Richards, *Logic and Language Models for Computer Science*, 4^{th} Edition

Course Description

This course is an introduction to two kinds of formal systems - languages (which are treated as sets of strings) and logics - with important applications to computer science. The study of formal languages underlies important aspects of compilers and other language processing systems, as well as the theory of computation. Various systems of logic and automatic reasoning are put to use in artificial intelligence, database theory and software engineering. The entire course will give you practice in precise thinking and proof methods that play a role in the analysis of algorithms.

Objectives and Outcomes

After this course, you should be able to. . .

- Understand the concepts and relevance of logic, formal languages and automata theory, and computability.
- Do mechanical formal proofs, prove program correctness for simple programs, and solve problems in first-order logic.
- Solve problems in elementary machine models: designing finite-state automata, pushdown automata and Turing machines.
- Solve problems in formal languages: writing regular expressions, regular grammars, and context-free grammars.

Logistics

- **Office Hours:** All lectures and office hours will meet in person. My office hours should be viewed as study sessions. All are welcome at the same time! I'll take questions and we'll work through problems together. For students that expect to struggle with the material, I strongly encourage you to attend at least one, and preferably both hours each week. To speak to me privately, please email me ahead of time, and I'll reserve some time for a private discussion, likely at end of office hours.
- **Homework:** It will be very hard to do well in this course if you do not do all of the homework by yourself, including any optional problems. You are strongly encouraged to do all of the problems, and to ask questions, in class and in office hours, when you do not understand any of them. Don't start the homework the day before it is due!
- **Gradescope** Quizzes, homeworks and exams will all be submitted through Gradescope. You can find gradescope through Blackboard: click on Tools, then gradescope. You should also be able to access it directly from the gradescope website, if you use your GMU login. When submitting an assignment, *please* mark each question with the appropriate question number, as this makes grading much easier.
- **Overleaf** I will release the assignments on overleaf. This is a web-based platform for writing latex documents. You do not need special software, and I will not insist that you use latex to write your answers. You can simply view the PDF from the webpage, and submit answers to Gradescope in whatever format you like. However, I **encourage** you to use latex - it is fairly easy, and produces nice PDFs. To do that, just copy the project that I've shared, and edit.

Topics

- Logical proofs
  - Propositional Logic (including truth tables; boolean algebra)
  - Rules of Inference (proof by deduction)
  - Mathematical Induction
- Predicate Logic (including quantifiers)
- Program Verification (including loop invariants)
- Regular Languages and conversions:
  - Regular Grammars
  - Finite Automata (including deterministic and non-deterministic FAs)
  - Regular Expressions
- Context-Free Languages
  - Context-Free Grammars
  - Push-Down Automata
- Turing Machines

Grades

- Homework: 30%
  - Homework will be assigned weekly.

  - The lowest homework score is dropped.
  - Part of the homework assignment will be posted on GradeScope and will be graded.

- Quizzes: 10%
  - Quizzes will be weekly except when displaced by exams.
  - The lowest two quiz scores are dropped.
  - Quizzes are open book and open notes, but individual and not open Internet (except as necessary for taking and submitting the quiz).
  - Quizzes will be 30 minutes, open on GradeScope Friday-Sunday every week in which there is a quiz.

- Exams (2): 30% + 25%
  - In-class, unless otherwise dictated by circumstances.
  - Final exams is not cumulative.
  - The higher-scoring exam gets the higher weight, while the lower-scoring exam gets the lower weight.
  - Closed book; one sheet of handwritten notes (8.5×11in; double-sided) is permitted.
  - Be prepared to show your GMU ID on exam days.

- Class Participation: 5%
  Participation grades will be positively impacted by:
  - Weekly Practice Questions: completion and engagement with weekly practice questions as outlined in the schedule.
  - Active Participation: Contributing to class discussions by asking questions or providing answers during lectures.
  - Note Sharing: participation in collaborative note-sharing platforms, including contributing to shared documents or summarizing key concepts from class discussions.
  - Quality over Quantity: Participation is measured not just by frequency but by the quality of contributions. Thoughtful questions and insights are valued.
  - Peer Support: Helping fellow classmates by clarifying concepts through note-sharing platforms.
  - Class Attendance.

- **Late Work:**
  - No late/make-up quizzes will be accepted.
  - Homework can be submitted up to 48 hours late with a 10% penalty. No submissions accepted after 48 hours.
  - Please coordinate with the instructor *in advance* for any special circumstances requiring a make-up exam.

- There will be no programming assignment.

Grade Scale

Final grades will be assigned according to the following scale:

A+	98 – 100	C+	78 – 79
A	92 – 97	C	72 – 77
A–	90 – 91	C–	70 – 71
B+	88 – 89	D	60 – 69
B	82 – 87	F	0 – 59
B–	80 – 81		

Advising Requirement

It is a departmental requirement that all undergraduate Computer Science students taking CS330 **must speak with their faculty advisor** during the semester and submit an advising form (found here) documenting their visit.

- Upload your completed and signed form to Blackboard; scan if necessary.
- **Failure to complete the advising requirement will result in an Incomplete grade in CS 330.**
- Your *faculty advisor* is a professor who has been assigned to you, not the CS departmental advising staff; look for an email from the department informing you who your faculty advisor is.
- Non CS-majors and graduate students are exempt from the advising requirement.
- Students who are taking CS110 and CS330 during the same semester only need to complete one form.
- Please complete the advising requirement **before the midterm date**; your advisor may be busy and unable to meet towards the end of the semester.
- **What is the goal of the advising requirement?**
  - To motivate you to plan ahead when choosing classes.
  - To encourage you to take the opportunity to ask a faculty member any questions you may have about your academic plans.
  - To check that there are no circumstances that you might have overlooked which might hinder your academic progress.
  - To advise you of things to consider if you are contemplating graduate school.

Honor Code

All graded work (not including weekly practice questions) in this class is individual. Any direct contribution on an exam, quiz, or assignment will be treated as a violation of George Mason's Honor Code and the CS Department Honor Code, and will typically result in failing the class.
Some kinds of participation in third-party online study sites violate the GMU Honor code: these include accessing questions for this class which have been uploaded by others; accessing exam or assignment answers for this class; uploading of any of the instructor's materials or exams; and uploading any of your own answers or finished work. It is **your responsibility** to protect your work, including protecting your computer with a password and avoiding sites which make your work publicly visible. Always consult with the professor before using these sites.

Please respect the importance of upholding the Honor Code, since it affects the meaningfulness of your degree and the degrees of other students. As a practical matter, an understanding of the material presented in this course has a potential to positively impact your ability to acquire computing

skills and perform computing skill which will be used in your future careers; you put yourself in the best position to gain that understanding when you rely on your own work.

Privacy Statement

All course materials posted to Blackboard or other course site are private to this class; by federal law, any materials that identify specific students (via their name, voice, or image) must not be shared with anyone not enrolled in this class. In the event that any class meetings need to be held synchronously online, those classes will be recorded to provide necessary information for students in this class. Recordings will be stored on Blackboard and will only be accessible to students taking this course during this semester.

Disability Accommodations

Disability Services at George Mason University is committed to providing equitable access to learning opportunities for all students by upholding the laws that ensure equal treatment of people with disabilities. Students seeking accommodations for this class, please first visit Disability Services (ods@gmu.edu ; 703-993-2474) for detailed information about the Disability Services registration process. Then please discuss the approved accommodations with the instructor. The Disability Services office can be found in Student Union Building I (SUB I), Suite 2500.

Diversity and Inclusion

George Mason University promotes a diverse, inclusive, and anti-racist environment, under the belief that a just and equitable learning environment is a strong learning environment. Students are valued as individuals, irrespective of differences in race, ethnicity, national origin, first language, economic status, gender, gender expression and identity, sexual orientation, religion, disability, or age. As an important member of the GMU community, the Department of Computer Science is integral to the goal of cultivating an environment which is committed to inclusion and anti-racism.

Students who prefer to be addressed by a specific name or gender pronouns should share this information with the instructor (he/him). Additionally, name and pronouns can be changed in the GMU records.

Title IX

As a faculty member and designated "Responsible Employee," I am required to report all disclosures of sexual assault, interpersonal violence, and stalking to Mason's Title IX Coordinator, per university policy 1412.

Students who wish to speak with someone confidentially should contact the Student Support and Advocacy Center (ssac@gmu.edu; 703-993-3686) or Counseling and Psychological Services (caps@gmu.edu; 703-993-2380). Assistance may also be sought from GMU's Title IX Coordinator (titleix@gmu.edu; 703-993-8730).

For more information, please check out GMU's Common Course Policies.

Tentative Schedule

Week	Date	Topic	Reading Sections	Assignments/Notes
Week 1	8/26 - 8/28 9/1	Introduction; Propositional logic and Proofs	1.1 - 1.6; 2.1 - 2.6	Practice: 2.4, 2.8, 2.9, 2.10, 2.11 Quiz 1 (Ch 1 and 2)
Week 2	9/2 9/4 9/8	**Labor Day** Proof by Deduction	3.1 - 3.7	Pr: 3.7, 3.8, 3.10 Quiz 2 (Ch 3)
Week 3	9/9 - 9/11 9/13 9/215	Predicate Logic	4.1 - 4.5	Pr: 4.1, 4.3, 4.7, 4.10 HW 1 due Quiz 3 (Ch 4)
Week 4	9/16 - 9/18 9/20 9/22	Mathematical Induction	5.1, 5.2, 5.4, 5.5	Pr: 5.2 - 5.4, 5.10 HW 2 due Quiz 4 (Ch 5)
Week 5	9/23 - 9/25 9/27 9/29	Program Verification	6.1 - 6.4	Practice: 6.2 - 6.6 HW 3 due Quiz 5 (Ch 6)
Week 6	9/30 - 10/2 10/4	Midterm Review Covers Ch 1 - Ch 6	-	HW 4 due
Week 7	10/7 10/9 10/11	Language Basics; Regular Languages **Midterm**	Ch 7; 8.1 - 8.4	Pr: 7.4, 7.5, 7.12, 7.15 HW 5 due
Week 8	10/14 10/16	**Fall Break** Language Basics; Regular Languages	Ch 7; 8.1 - 8.4	Pr: 8.2, 8.3, 8.6
Week 9	10/21 - 10/23 10/27	Regular Expressions; Regular Grammars	8.4, 8.6, 8.7	Pr: 8.8, 8.9, 8.11, 8.12 Quiz 6 (Lngs)
Week 10	10/28 - 10/30 11/1 11/3	Regular Grammar Conversions	8.8, 8.9	Pr: 8.14, 8.15 HW 6 due Quiz 7 (REs/RGs)
Week 11	11/4 - 11/6 11/8 11/10	Finite Automata	9.1 - 9.4, 9.8	Pr: 9.4, 9.8, 9.16a, 9.17 HW 7 due Quiz 8 (RGs)
Week 12	11/11 - 11/13 11/15 11/17	Nondeterministic Finite Automata; Properties of Regular Languages	9.5 - 9.7	Pr: 9.5, 9.6, 9.25 HW 8 due Quiz 9 (DFAs)

Week	Date	Topic	Reading Sections	Assignments/Notes
Week 13	11/18 - 11/20 11/22 11/24	Context Free Grammars	10.1 - 10.4	Pr: 10.1, 10.2, 10.7 HW 9 due Quiz 10 (NFAs)
Week 14	11/25 11/27	Pushdown Automata **Thanksgiving Break**	11.1, 11.2, 12.2	Pr: 11.1, 11.4, 11.6
Week 15	12/2 - 11/4 12/6 12/8	Final Review	-	- HW 10 due Quiz 11 (Ch10)
Week 16	12/9 - 12/11	Reading Days; Optional in-class group study	-	-
Week 17	12/16 - 12/18	Final Exam	-	-