CS 330: Formal Methods and Models (Fall 2024)

Section 006: T/T 3:00pm-4:15pm - Buchanan Hall D023

Instructor

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Course requirements

Prerequisites: CS211 and MATH125 (C or better in both)
Textbook: Richards and Hamburger, *Logic and Language Models for Computer Science,* **4th** Edition

Course resources

- **Blackboard** to view course materials, grades, and announcements.
- **Piazza** for questions and discussions.
- **GradeScope** for quizzes**.**

Schedule

See below for schedule; **subject to change**; **check it regularly**.

Description

This course is an introduction to two kinds of formal systems – logics and languages - 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 used 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.

Outcomes

- Students will understand the concepts and relevance of logic, formal languages and automata theory, and computability.

- Students will be able to do mechanical formal proofs, program correctness proofs and solve problems in first-order logic.
- Students will be able to solve problems in elementary machine models: designing finite-state, pushdown and Turing machines.
- Students will be able to solve problems in formal languages: writing regular expressions, regular grammars, and context-free grammars.

Topics

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

Grades

- Homeworks: 30%
    - Homeworks will be assigned weekly.
    - The lowest homework score is dropped.
    - There are two types of homeworks.
        - Practice HWs: for practice only and will **not** be graded.
        - Turn-in HWs: posted on Blackboard and will be graded.
    - Late submission/make-up is not accepted.
- Quizzes: 10%
    - Quizzes will be weekly except when displaced by exams.
    - Quizzes will be posted on GradeScope.
    - 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).
    - Late submission/make-up is not accepted.
- Exams (2): 35% + 25%
    - Midterm and Final exams.
    - Held in-class.
    - Final exam 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.
    - No make-up for missed exam is permitted except for a university-accepted excused absence. In that case, students must reach out to the instructor with documentation within 24 hours of your absence to make arrangements for a make-up.
- Advising: 0%
    - Advising will not affect your grade, but not completing the requirement will prevent you from getting a grade.
    - See the Advising Requirement section below for more details.
- *There will be no programming assignment.*
- *For grade disputes, please contact the grader (Teaching Assistant for Homeworks and Quizzes, Professor for Exams). You must initiate a dispute within **one week** of receiving your grade for the dispute to be considered.*

Grading Scale

- *There will be **no make-up or extra-credit assignments** at the end of the semester.*
- 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	<60
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 (inform me if that is the case for you).
- 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/Academic Standards

All graded work 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, Academic Standards Code, and the CS Department Honor Code, and will result in failing the class.

The use of AI tools (including but not limited to ChatGPT) to aid in the completion of graded assignments/quizzes/exams, and the use of solutions which are derived directly or indirectly from AI prompts, is considered unauthorized assistance, and is prohibited under the honor code.

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 (She/her). 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).

COVID-19

This class is in person during the current semester. For information regarding the virus and current university policy regarding the virus, consult the Safe Return to Campus page.

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

Tentative Schedule

Week	Topic	Reading Chapters	Assignments/Notes
Week 1	Introduction; Mathematical Preliminaries; Propositional Logic	1.1-1.6 2.1-2.6	Practice 2.4, 2.7a, 2.8, 2.9, 2.11
Week 2	Propositional Logic Proofs by Deduction	2.1-2.6 3.1-3.9	Practice 3.8, 3.10 HW1 release Quiz 1
Week 3	Proofs by Deduction Predicate Logic	3.1-3.9 4.1-4.5	Practice 4.1, 4.3, 4.7, 4.10 HW1 due, HW2 release Quiz 2
Week 4	Predicate Mathematical Induction	4.1-4.5 5.1-5.5	Practice 5.2-5.4, 5.9

			HW2 due, HW3 release Quiz 3
Week 5	Mathematical Induction Program Verification	5.1-5.5 6.1-6.4	Practice 6.2-6.4, 6.6, 6.7 HW3 due, HW4 release Quiz 4
Week 6	Program Verification Midterm Review	6.1-6.4	HW4 due, HW5 release Quiz 5
Week 7	**Midterm Exam** Language Basics Regular Languages	 7 8.1-8.2	Practice 7.4, 7.5, 7.12, 7.15, 8.2, 8.3, 8.5, 8.6 HW5 due
Week 8	Fall Break Language Basics Regular Languages Regular Expressions Regular Grammars	7 8.1-8.2 8.2-8.5	Practice 8.8, 8.11, 8.12 HW6 release Quiz 6
Week 9	Regular Expressions Regular Grammars Regular Grammar Conversions	8.2-8.5 8.5-8.6	Practice 8.14, 8.15 HW6 due, HW7 release Quiz 7
Week 10	Regular Grammar Conversions Finite Automata	8.5-8.6 9.1-9.4, 9.8	Practice 9.5, 9.7, 9.16, 9.17 HW7 due, HW8 release Quiz 8
Week 11	Finite Automata	9.1-9.4, 9.8	HW8 due, HW9 release Quiz 9
Week 12	Nondeterministic Finite Automata Properties of Regular Languages	9.5-9.7	Practice 9.8, 9.9, 9.25 HW9 due, HW10 release Quiz 10
Week 13	Context-Free Grammars	10.1-10.4	Practice 10.1, 10.2, 10.8

			HW10 due, HW11 release Quiz 11
Week 14	Pushdown Automata, Turing Machines	11.1-11.2 12.2	Practice 11.1, 11.4, 11.6, 11.9
Week 15	Pushdown Automata Turing Machines Final Exam review	11.1-11.2 12.2	HW11 due Quiz 12
Week 16	Reading days **Final Exam**		