Syllabus – Interim Version

(An updated version will be posted during the first week of classes)

Course Number: CS 530

Course Title: Mathematical Foundations of Computer Science

Instructor Name: Prof. Radu Negulescu, PhD
Semester and Year: Fall 2024
Class Meeting Location(s), Day(s) and Time(s), and Modality/ies:
Section 006: ENT 178, Fridays 1:30-4:10 pm
Section 007: ENGR 1101, Thursdays 7:20-10:00 pm

Instructor Contact Information:
rnegules@gmu.edu
Office: RSCH 364
Office hours: Thursdays 6:00-7:00 pm, Fridays 4:30-5:30 pm, Tuesdays 12:00-1:00 pm

Teaching Assistants:
Yuqing Zhou
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Office hours: TBA, in ENGR 4456

Course Description/Overview:

This course focuses on the topics of basic mathematical structures, mathematical logic and probability theory; and application of these concepts to problem solving and formal reasoning through hand-on practice with the use of computational tools.

Prerequisites:

Recommended prerequisites include MATH 125 and STAT 344. While they are not a registration requirement, students are encouraged to review the course material and discuss any gaps with the course instructor.

Course Learning Outcomes:

The primary purpose of this course is to instill the mathematical abilities needed for student success in GMU's Computer Science Master program.

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

- **CO 1**. Conceptually interpret foundational mathematical notions such as sets, relations, functions, recurrence relations, recursion, and mathematical induction, and apply them to the formulation of proofs
- **CO 2**. Use basic concepts in number theory and apply them to problems in cryptography
- **CO 3**. Demonstrate familiarity with formal concepts in formal mathematical logic, including propositional logic, soundness and completeness, and predicate logic; and interpret, formulate, apply, and prove formal mathematical logic expressions
- **CO 4**. Apply the basic principles of probability, including probability rules, probability spaces, probability density, joint probabilities, conditional probabilities, and Bayes theorem; and use probabilistic reasoning to solve problems
- **CO 5**. Apply random variables, expectations, statistical distributions, and Bayes rule to solve problems in Computer Science

Textbook and Reference Materials:

1. Mathematics for Computer Science by E. Lehman, F.T. Leighton and A.R. Meyer; see https://courses.csail.mit.edu/6.042/spring18/mcs.pdf
2. Practice problems with Solutions (MIT Course 6.042)
    a. 2010 Fall - https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-fall-2010/pages/exams/
    b. 2005 Fall - https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-fall-2005/pages/exams/
3. Supplemental materials:
    a. Lecture Notes on Mathematical Logic by Vladimir Lifschitz (https://www.cs.utexas.edu/users/vl/teaching/388Lnotes.pdf)
    b. Probability course notes by Richard Weber (http://www.statslab.cam.ac.uk/~rrw1/prob/prob-weber.pdf)

Grading Schema:

The recorded letter grades shall be determined by the weighted average of coursework grades, adjusted with bonuses and penalties, according the following cutoff levels:

GRADE	CUTOFF	MEANING
A+	98	Consistently performs above and beyond the course/assignment requirements
A	92	Consistently performs above and beyond the course/assignment requirements
A-	90	Consistently performs above and beyond the course/assignment requirements
B+	88	Meets and occasionally exceeds the course/assignment requirements
B	82	Meets and occasionally exceeds the course/assignment requirements
B-	80	Meets and occasionally exceeds the course/assignment requirements
C	70	Minimally meets the course/assignment requirements
F		Fails to meet the course/assignment requirements

No rounding or truncation will be applied prior to assigning the letter grades.

Grade Weights:

COURSEWORK	WEIGHT	SUBMISSION
Class exercises	10	Group
Homework assignments	40	Individual
Midterm exam	20	Individual
Final exam	30	Individual

All coursework can be completed with open book and open notes. However, the use of the internet and online resources is not permitted for coursework, except to access our course's Canvas, Gradescope, and Piazza accounts.

Grading-related Policies:

- Homework can be turned in **at most 24 hours** late.
- Submitting an assignment late incurs a **25%** ceiling penalty so that RecordedGrade = min(75%, RawGrade).
- There is an emphasis on developing a strong understanding of the material through practice. It is important to take time to fully understand how to arrive at the answers. Bonus points will be awarded up to a maximum of 5% of the course grade to encourage efforts to understand the course material:
    - One bonus point for the first student to spot each mathematical error in the course material or at a lecture
    - One bonus point for the first student to answer a bonus question – a key question posed by the instructor in class to test the understanding of the material
- Contesting of the grade on any submission must be requested within one week of receiving that grade. No grade change requests will be considered past the contesting deadline
- All students are expected to abide by the GMU honor code and the GMU CS honor code. Please review these honor code documents for precise definitions of expectations:

    http://cs.gmu.edu/resources/honor-code

    https://oai.gmu.edu/full-honor-code-document/

- There will be no make-up or extra-credit assignments at the end of the semester; your grade should be a measure of your semester-long progress
- IN (Incomplete) policy as indicated in the catalogue will be strictly adhered to. Students who wish to use it must provide the necessary back-up documentation (e.g. medical certificate) for their application to be considered favourably. Awritten request for an IN grade, with complete back-up documentation, must be received before the final exam week

Hardware and Software Needs:

For in-class coursework including class exercises and exams, you will need a laptop computer with at least 2 GB of RAM and a fast, reliable wifi card. The recommended computer monitor and laptop screen size is 13-inches or larger. You will need computer speakers or headphones to listen to recorded content. A webcam and headset microphone are required for live audio sessions using course tools like Honorlock.

For the computer hard disk space required, consider and allow for the space needed to:

- Install the required and recommended software
- Save your course assignments

You are strongly encouraged to back up all contents of your computer on a regular basis. Loss of data will not excuse late or unsubmitted assignments.

Our coursework can be completed without any additional software installations, by simply using the Gradescope setup we provide and a text editor. However, to fully benefit from the skills we teach, we recommend installing a theorem prover and reproducing some of the required experiments on your own machine. Recommended software applications include the following:

- Python 3.12 or newer https://www.python.org/downloads/
  - o Z3 module (use `pip install z3-solver`, then `import z3` in your program)
- Visual Studio Code https://code.visualstudio.com/download
  - o Python extension to Visual Studio Code (search for Extensions in VSC)

Note: Our coursework can be completed without Python, Z3, or VSCode, by using just a text editor and our Gradescope assignment configurations. No knowledge of Python, Z3, or VSCode is required to complete any of the coursework. However, we recommend installing and using Python, Z3, and VSCode to students who would use automatic proofs outside our Gradescope setup.

Note: JSONiq is not required in our sections. Instead, we will be using the Z3 prover module in Python and wolframalpha (Mathematica) to demonstrate uses of automatic reasoning.

While typesetting assignment solutions is not required, students are strongly encouraged to create a free Overleaf account and use LaTeX for editing documents in mathematics and Computer Science. Overleaf has a good online tutorial for learning LaTeX: https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes

Communication:

We encourage using Piazza for all course-related communication. The teaching staff reserves the right to forward any course-related emails to Piazza, and make the sender known to the rest of the class.

Access page: TBD

Tentative Schedule:

DATES	TOPICS	TEXTBOOK SECTIONS	COURSEWORK
Aug 29-30	**Proofs, Sets, Relations**	1.3, 1.6, 1.8, 2.1, 2.2, 4.1, 4.3, 4.4, 8.3	
Sep 5-6	**Induction**	5.1, 5.2, 7.1	HW1 out
Sep 12-13	**Recursion**	7.2, 7.3	HW1 due
Sep 19-20	**Greatest common divisor**	9.1, 9.2	HW2 out
Sep 26-27	**Cryptography**	9.3, 9.4, 9.5, 9.6, 9.7, 9.9, 9.10, 9.11	HW2 due
Oct 3-4	**Propositional formulas**	3.1, 3.3	
Oct 10-11	**Midterm exam**	-	
Oct 17-18	**Propositional algebra**	3.4, 3.5	HW3 out
Oct 24-25	**Predicate algebra**	3.6	HW3 due
Oct 31-Nov 1	**Automatic theorem proving**	Class handouts	HW4 out
Nov 7-8	**Classical probability**	15.1, 15.3, 15.4, 15.5, 15.7	HW4 due
Nov 14-15	**Probability spaces**	17.1, 17.2, 17.5.1-17.5.4	HW5 out
Nov 21-22	**Conditional probability**	18.2, 18.3, 18.4, 18.5, 18.7	HW5 due
Nov 27-28	**No classes (Thanksgiving break)**	-	
Dec 5-6	**Random variables**	19.1, 19.2, 19.3, 19.4	
Dec 12-13	**Final exam**	-	

Note: The course schedule may change during the term. Changes will be announced in class and in the course Piazza.

Common Policies for GMU Courses

Academic Standards

Academic standards exist to promote authentic scholarship, support the institution's goal of maintaining high standards of academic excellence, and encourage continued ethical behavior of faculty and students to cultivate an educational community which values integrity and produces graduates who carry this commitment forward into professional practice.

As members of the George Mason University community, we are committed to fostering an environment of trust, respect, and scholarly excellence. Our academic standards are the foundation of this commitment, guiding our behavior and interactions within this academic community. The practices for implementing these standards adapt to modern practices, disciplinary contexts, and technological advancements. Our standards are embodied in our courses, policies, and scholarship, and are upheld in the following principles:

- **Honesty:** Providing accurate information in all academic endeavors, including communications, assignments, and examinations.
- **Acknowledgement:** Giving proper credit for all contributions to one's work. This involves the use of accurate citations and references for any ideas, words, or materials created by others in the style appropriate to the discipline. It also includes acknowledging shared authorship in group projects, co-authored pieces, and project reports.
- **Uniqueness of Work:** Ensuring that all submitted work is the result of one's own effort and is original, including free from self-plagiarism. This principle extends to written assignments, code, presentations, exams, and all other forms of academic work.

Violations of these standards—including but not limited to plagiarism, fabrication, and cheating—are taken seriously and will be addressed in accordance with university policies. The process for reporting, investigating, and adjudicating violations is outlined in the university's procedures (https://academicstandards.gmu.edu/). Consequences of violations may include academic sanctions, disciplinary actions, and other measures necessary to uphold the integrity of our academic community.

The principles outlined in these academic standards reflect our collective commitment to upholding the highest standards of honesty, acknowledgement, and uniqueness of work. By adhering to these principles, we ensure the continued excellence and integrity of George Mason University's academic community.

Student responsibility: Students are responsible for understanding how these general expectations regarding academic standards apply to each course, assignment, or exam they participate in; students should ask their instructor for clarification on any aspect that is not clear to them.

Accommodations for Students with Disabilities:

Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration of University Life, Disability Services implements and coordinates reasonable accommodations and disability-related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at George Mason University. If you are seeking accommodations, please visit https://ds.gmu.edu/ for detailed information about the Disability Services registration process. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email: ods@gmu.edu. Phone: (703) 993-2474.

Student responsibility: Students are responsible for registering with Disability Services and communicating about their approved accommodations with their instructor *in advance* of any relevant class meeting, assignment, or exam.

FERPA and Use of GMU Email Addresses for Course Communication:

The Family Educational Rights and Privacy Act (FERPA) governs the disclosure of education records for eligible students and is an essential aspect of any course. **Students must use their GMU email account** to receive important University information, including communications related to this class. Instructors will not respond to messages sent from or send messages regarding course content to a non-GMU email address.

Student responsibility: Students are responsible for checking their GMU email regularly for course-related information, and/or ensuring that GMU email messages are forwarded to an account they do check.

Title IX Resources and Required Reporting:

As a part of George Mason University's commitment to providing a safe and non-discriminatory learning, living, and working environment for all members of the University community, the University does not discriminate on the basis of sex or gender in any of its education or employment programs and activities. Accordingly, **all non-confidential employees, including your faculty member, have a legal requirement to report to the Title IX Coordinator, all relevant details obtained directly or indirectly about any incident of Prohibited Conduct** (such as sexual harassment, sexual assault, gender-based stalking, dating/domestic violence). Upon notifying the Title IX Coordinator of possible Prohibited Conduct, the Title IX Coordinator will assess the report and determine if outreach is required. If outreach is required, the individual the report is about (the "Complainant") will receive a communication, likely in the form of an email, offering that person the option to meet with a representative of the Title IX office.

For more information about non-confidential employees, resources, and Prohibited Conduct, please see University Policy 1202: Sexual and Gender-Based Misconduct and Other Forms of Interpersonal Violence. Questions regarding Title IX can be directed to the Title IX Coordinator via email to TitleIX@gmu.edu, by phone at 703-993-8730, or in person on the Fairfax campus in Aquia 373.

Student opportunity: If you prefer to speak to someone ***confidentially***, please contact one of Mason's confidential employees in Student Support and Advocacy (SSAC), Counseling and Psychological Services (CAPS), Student Health Services (SHS), and/or the Office of the University Ombudsperson.

Land Acknowledgment Statement:

https://legacies.gmu.edu/about/land-acknowledgement-statement

Land acknowledgment engages all present in an ongoing indigenous protocol to enact meaningful, reciprocal relationships with ancestors and contemporary tribal nations. As a state university, we have a responsibility to include and support indigenous communities and sovereign tribes in our work.

At the place George Mason University occupies, we give greetings and thanksgivings

to these Potomac River life sources,

to the Doeg ancestors, who Virginia annihilated in violent campaigns while ripping their lands apart with the brutal system of African American enslavement,

to the recognized Virginia tribes who have lovingly stewarded these lands for millennia including the Rappahannock, Pamunkey, Upper Mattaponi, Chickahominy, Eastern Chickahominy, Nansemond, Monacan, Mattaponi, Patawomeck, and Nottaway, past, present, and future, and

to the Piscataway tribes, who have lived on both sides of the river from time immemorial.

Other Resources:

- Student Support Resources on Campus

Acknowledgment:

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