CS 530 Mathematical Foundations of Computer Science
Syllabus & Assignments: Spring 2018

Instructor: Prof. William D. Ellis E-mail: wellis1@gmu.edu
Office Hours: By appt. Wed. 5-6 PM 5321 Engineering Bldg.

Web Site: Syllabus updates, sample problems & solutions, lecture notes etc. are posted weekly after class at https://mymasonportal.gmu.edu.

Schedule: 14 Classes 7:20-10:00 PM Arts & Design Bldg, Room L008
- Wednesdays 1/24/2018 - 5/2/2018 except March 14, 2018
- The Final Exam will be Wednesday May 9, 2018, 7:30-10:15 PM

Prerequisite: (1) Math 125 or INFS 501, and (2) STAT 344

Topics: We will study the mathematical foundations of Computer Science: basic mathematical structures, mathematical logic, and probability theory. We will apply these concepts to problem solving and formal reasoning. Students will get significant hands-on practice including through the use of computational tools.

Textbooks: (1) "ROSEN": Discrete Mathematics and Its Applications, 7th ed. By Kenneth H. Rosen, ISBN 978-0-07-338309-5, McGraw Hill Mathematical Foundations of Computer Science
We'll also use, to a lesser extent, two textbooks that are free on-line. Download them before the links go bad!
(2) "LEHMAN": Mathematics for Computer Science by E. Lehman, F.T. Leighton and A.R. Meyer, rev. June 5, 2017 (https://courses.csail.mit.edu/6.042/spring17/mcs.pdf)
(3) "WEBER": Probability course notes by Richard Weber (http://www.statslab.cam.ac.uk/~rrw1/prob/prob-weber.pdf).

Exams: We will have: (i) 2 Quizzes, (ii) 2 Hour Exams, and (iii) a comprehensive Final Exam (Wednesday May 9, 2018). Exams and Quizzes will be given only one time - no makeup exams. Use all available classroom space, avoid sitting close to anyone else, and do not sit next to a friend. No partial credit will be given for a purported proof to a false statement. It is forbidden to use cellphones or computers, or to share any calculators or materials.

Grades: 1 Final Exam: 45% of final grade.
2 Hour Exams: 40% of the final grade (20% each)
2 Quizzes and Homework together: 15% of final grade.

Help: Questions? Send me an e-mail! Use the ^ symbol for exponents, * for multiplication. You may also e-mail a scanned image or pdf.

Homework: Homework assignments will be on the weekly Syllabus updates. See http://mymason.gmu.edu. Homework will never be accepted late. However, of the 13 Homework assignments, only the 12 with the highest percentage scores will be counted toward your grade.

Honor Code: Honor Code violations are reported to the Honor Committee. See http://cs.gmu.edu/wiki/pmwiki.php/HonorCode/CSHonorCodePolicies However, collaborating on homework is okay only for Spring 2018 CS530.

E-mail: Use your Mason email for all e-mails with me (to comply with privacy rules). You may forward your GMU email elsewhere, but I may respond only to mail from a Mason email account.

Syllabus and HW are updated each week after class. Rev. JAN 21, 2018 (7:55 PM)

Course Content

1. Foundations

- Set Theory: Sets, relations and functions, composition, inversion
- Algebra of sets, binary relations, and graphs
- Induction and recursion
- Structural inductions, inductive definitions
- Recurrence Relations, solving recurrence relations and generating functions
- Number Theory

2. Mathematical Logic

- Propositional logic (syntax and semantics; transforming English specification into logical statements and creating proofs; consistence and completeness w/out proofs)
- Predicate logic w/examples (syntax and semantics; transforming English specification into logical statements; consistence and completeness w/out proofs)
- Practice/problem solving by proving theorems/finding counterexamples; hand vs. mechanized proofs and counterexamples; theorem proving vs. model checking
- Practice with computing applications

3. Probability Theory

- Sample spaces, possibility trees, probability set function and axioms
- Discrete and continuous random variables
- Joint, marginal, and conditional probabilities
- Bayes' theorem
- Expectations, mean, variance, covariance
- Independent events and independent random variables
- Univariate and multivariate normal (Gaussian) distribution
- Other distributions: Poisson, Exponential, Bernoulli, Binomial, Multinomial, Exponential, and Benford's Law
- Biased and unbiased estimators
- Maximum likelihood estimation
- Bayesian inference (e.g. for the Gaussian)
- Examples of applications in Computer Science

Semester Schedule: Hour-Exam and Quiz Dates Are Subject to Change

Class	Date	Event	Details
(1)	Jan 24, 2018	1st Class	
(2)	Jan 31, 2018		
(3)	Feb 7, 2018		
(4)	Feb 14, 2018	Quiz 1	No usage of a computer or cell phone is permitted during any exam or quiz.
(5)	Feb 21, 2018		
(6)	Feb 28, 2018		
(7)	Mar 7, 2018		
	Mar 14, 2018	no class	Spring Vacation!
(8)	Mar 21, 2018	Exam 1 & Lecture	Exam 1 will cover everything that we covered in HW#1-#6. Problems will be like in the HW, in Quiz 1, in Sample Quiz 2, and the sample Questions for Exam 1. No usage of a computer or cell phone is permitted during any exam or quiz.
(9)	Mar 28, 2018		
(10)	Apr 4, 2018		
(11)	Apr 11, 2018	Quiz 2	No usage of a computer or cell phone is permitted during any exam or quiz.
(12)	Apr 18, 2018		
(13)	Apr 25, 2018		
(14)	May 2, 2018	Exam 2 & Lecture	• Exam 2 will cover everything that we covered in HW#7-#13. Problems will be like in the HW, in Quiz 2, in Sample Quiz 2, and the sample Questions for Exam 2. • No usage of a computer or cell phone is permitted during any exam or quiz.
(15)	May 9, 2018	FINAL EXAM	• The Final Exam starts at 7:30 PM (not 7:20) Wednesday 5/9/2018. • The Final Exam covers everything that was covered during the entire semester. • The Final Exam will be neither Open Book and Open Notes. • Problems will be like in the HW, in the quizzes and exams, and in the sample quizzes and sample exams. • No usage of a computer or cell phone is permitted during any exam or quiz.

Row	Text	Homework Assignments	Due
(1)		Read LEHMAN: §§ 3.0-3.2.1 (pdf-pages 47-54), Read ROSEN: • § 1.1 (pages 1-12); • § 1.2 through Example 5 (pgs 16-18); and • § 1.3 through Example 9 (pgs 25-31). Learn Table 6 Logical Equivalences (ROSEN pg 27)	1/31/2018
(2)	Rosen § 1.1 (pg 13)	#10; #28; and #Let s = "p=>q." Construct a truth table that has one column each for: (i) s, (ii) converse(s), (iii) inverse(s), and (iv) contrapositive(s). State which pairs of (i)-(iv) are logically equivalent to each other.	
(3)	Rosen § 1.2 (pg 22)	#12. Hints for the same problem are on pdf-page 81 of LEHMAN. Also compare with ROSEN page 18 Example 4. Example 4 is solved with a Truth Table in our Week-1 Lecture Notes.	
(4)	Rosen § 1.3 (pg 35)	#8; #10; #28; #30; #32; #42; #Rewrite in if-then form the statement: "Do your homework or you won't be able to design the algorithm." Hint: See ¶6 Example 3 in the Week 1 Lecture Notes. Solve #42 only for the formula p∨(q∧r) in Truth Table 5 on page 27 of ROSEN. This requires writing p∨(q∧r) as the disjunction of AND clauses A∧B∧C where A=p or A=-p, B=q or B=-q, C=r or C=-r. Hint: The AND clauses are like in ROSEN #1.1.40. A similar problem is solved in LEHMAN § 3.4.1, pdf-pages 57-58. The solution is called the "Full Disjunctive Normal Form" of (p∨(q∧r).	