# CS 530 Syllabus & Assignments: Spring 2017

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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 http://mymason.gmu.edu.

Schedule: 14 Classes 7:20-10:00 PM Innovation Hall, Room 136
- Wednesdays 1/25/2017 - 5/3/2017 except March 15, 2017
- The Final Exam will be Wednesday May 10, 2017, 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: Our 4 textbooks are available free on-line.
(1) ("AHO"): Foundations of Computer Science by Alfred V. Aho and Jeffrey D. Ullman (Lehn)
(http://infolab.stanford.edu/~ullman/focs.html)
(2) "LEHMAN": Mathematics for Computer Science by E. Lehman, F.T. Leighton and A.R. Meyer, rev. Wed. 28th September, 2016 (new) (https://courses.csail.mit.edu/6.042/spring16/mcs.pdf)
(3) "LIFSCHITZ": Lecture Notes on Mathematical Logic by Vladimir Lifschitz
(https://www.cs.utexas.edu/users/vl/teaching/388Lnotes.pdf)
(4) "WEBER": Probability course notes by Richard Weber
(http://www.statslab.cam.ac.uk/~rrw1/prob/prob-weber.pdf)
- Additional material will be provided by the instructor.

Exams: We will have: (i) 2 Quizzes, (ii) 2 Hour Exams, and (iii) a comprehensive Final Exam (Wednesday May 10, 2016). Exams and Quizzes will be given only one time - no makeup exams. I often give partial credit when grading. However, no partial credit will be given for a purported proof to a false statement. During an exam or quiz: Use all available classroom space, and do not sit next to a friend or close to anyone else.

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 (black/white) or a 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

E-mail: To comply with privacy rules, please use your Mason email for all e-mails with me. You may forward your campus email elsewhere, but I may respond only to a Mason email account.

Assignments are updated on Blackboard after each class. Rev. 1/25/2017

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 25, 2017 | 1st Class | |
| (2) | Feb 1, 2017 | | |
| (3) | Feb 8, 2017 | | |
| (4) | Feb 15, 2017 | Quiz 1 | The quiz will cover everything through Homework 2. |
| (5) | Feb 22, 2017 | | |
| (6) | Mar 1, 2017 | | |
| (7) | Mar 8, 2017 | Hour Exam & Lecture | The exam will cover everything that was covered in class through Class (7). |
| | Mar 15, 2017 | - no class | Spring Vacation! |
| (8) | Mar 22, 2017 | | |
| (9) | Mar 29, 2017 | | |
| (10) | Apr 5, 2017 | | |
| (11) | Apr 12, 2017 | Quiz 2 | |
| (12) | Apr 19, 2017 | | |
| (13) | Apr 26, 2017 | | |
| (14) | May 3, 2017 | Hour Exam & Lecture | |
| (15) | May 10, 2017 | FINAL EXAM | The Final Exam will cover everything that was covered during the entire semester. |

| Row | Text | Homework Assignments | Due |
|---|---|---|---|
| (1) | LEHMAN | Read §§ (sections) 1.1, 1.2 on proofs and predicates. Solve problem #1.4 (page 21). Read the tiny § 3.6.1 on quantifiers (page 62). | 2/1/2017 |
| (2) | LEHMAN | Read § 4.1 (pg 101) on set theory. Solve problems #4.1 (page 108), #4.3, #4.5. On problems 4.3 and 4.5, verity the propositional equivalences using truth tables. Prove the set equalities like in Theorem 4.1.2. | 2/1/2017 |
| (3) | AHO | Read §§ 7.2, 7.3, 7.7 on the algebra of sets. Solve problems #7.3.2 (pg 350), #7.7.1 (pg 373), #7.7.4, #7.7.6. (For 7.3.2, number Venn-Diagram regions, do not use shading.) | 2/1/2017 |
| (4) | LEHMAN | Read §§ 4.3-4.5 on Functions, and Relations. - Solve #4.17 (page 114), #4.18(a,c,d), #4.19 | 2/1/2017 |

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| Row | Text | Homework Assignments | Due |
|---|---|---|---|
| (5) | LEHMAN | Do problems #4.20, #4.22, #4.23, #4.24, #4.27. | |
| (6) | LEHMAN | Read §§ 5.1, 5.2, 5.3 on Mathematical Induction. - Prove $(16^n - 7^n)$ is divisible by 9 for every positive integer *n*. Solve #5.3, #5.4, #5.8, #5.12. | |
| (7) | LEHMAN | Read §§ 7.1, 7.4, 7.5 on Recursive Data types. - Solve #7.9, #7.17, #7.27, #7.28, #7.30. | |
| (8) | LEHMAN | Read §§ 10.1, 10.6, 10.7, 10.8, 10.9, 10.10, 10.11 on Directed Graphs, Partial Orders, and Equivalence Relations. - Solve #10.8, #10.26(a,b), #10.32, #10.33, #10.37, #10.42, #10.37 (except c, d), #10.45. | |
| (9) | LIFSCHITZ | Read § 1 and pages 15-18. Solve #1.3, #1.4, #1.5, #1.6, #1.7, #3.1 | |
| (10) | Obtain JSONiq (Zorba) installation at: http://mason.gmu.edu/~mnachawa/resources/jsoniq-environment.html<br>See the JSONiq manual at: http://www.jsoniq.org/docs/JSONiq/html/index.html | | |
| (11) | WEBER | Read §§ 4.1-4.3 on the probability axioms | |
| (12) | WEBER | Read §§ 5.2-5.5 on independence and important distributions. | |
| (13) | WEBER | Read §§ 6.1-6.4 on conditional probability and Bayes Theorem | |
| (14) | WEBER | Read §§ 7.1-7.5 on discrete random variables | |
| (15) | WEBER | Read §§ 8.1-8.2 on expectation and variance | |
| (16) | WEBER | Read §§ 9.1-9.2 on independent radom variables | |
| (17) | WEBER | Read §§ 13.1-13.2 on conditional distributions and condition expectations | |
| (18) | WEBER | Read §§ 16.1-16.2 on continuous random variables | |
| (19) | WEBER | Read §§ 17.1, 17.2, and 17.4 on functions of a continuous random variable. | |