# Introduction to Probability (MATH 380) – Fall 2016
# Syllabus

**Course Meetings:** MWF 10:35-11:25, Nord Hall 356.

**Instructor:** Peter Thomas, Yost 212, 368-3623 (dept. office 368-2880), e-mail = `pjthomas(at)case.edu`.

**Text:** *A First Course in Probability*, Ninth Edition, by Sheldon Ross, Pearson, Boston, Mass.

**Website:** Readings and assignments will be posted through google docs. Here is the course folder on google drive:

`https://drive.google.com/a/case.edu/folderview?`
`id=0B-JMPWjMi0msSTBFN1FxNVJtQ2M&usp=sharing`

Here is the course schedule on google spreadsheets:

`https://docs.google.com/a/case.edu/spreadsheets/`
`d/1DkMJms6ygziKnqY1Sbdl8XgDgEP_4PSWMwx68SGVKpY/edit?usp=sharing`

**Prerequisites:** MATH 122 or MATH 126 required. MATH 223 (MATH 227) are strongly recommended. The course will involve a mixture of conceptual study, rigorous proof, individual and group work, applications, and computational exercises using `MATLAB`. Students not already familiar with `MATLAB` should work through a tutorial before the semester starts. A free `MATLAB` tutorial is provided here:

`http://www.mathworks.com/academia/student_center/tutorials/`

**Description:** Combinatorial analysis. Permutations and combinations. Axioms of probability. Sample space and events. Equally likely outcomes. Conditional probability. Bayes formula. Independent events and trials. Discrete random variables, probability mass functions. Expected value, variance. Bernoulli, binomial, Poisson, geometric, negative binomial random variables. Continuous random variables, density functions. Expected value and variance. Uniform, normal, exponential, Gamma random variables. The De Moivre-Laplace limit theorem. Joint probability mass functions and densities. Independent random variables and the distribution of their sums. Covariance. Conditional expectations and distributions (discrete case). Moment generating functions. Law of large numbers. Central limit theorem. Additional topics (time permitting): the Poisson process, finite state space Markov chains, entropy.

**Grading:** There will be two one-hour midterm exams and a three-hour final exam. Each midterm will determine 20% of your grade, and the final will determine 40%. The remaining 20% of your grade will be based on daily homework assignments (15-20%) and (possibly) daily quizzes (0-5%) based on the assigned reading. The lowest quiz (if any) will be dropped from the final grade. The midterms will be on Monday, Oct. 10 and Friday, Nov. 11. The final exam will be Wednesday, Dec. 21 from 3:30-6:30 p.m. Please take exam dates into account when making your travel plans.

**Office hours** 8:30-9:20 am MWF; and by appointment (pjthomas–at–case.edu)

**Homework:** Homework will be assigned regularly, either during lecture or via the course website. Homework is due at the beginning of class one week after the day on which it is assigned. If you miss a class please make arrangements with other members of the class to find out the assigned problems. Late homework will be penalized following a geometric series. If the homework would have scored $x$ points, had it been on time, then if it is turned in $n$ days late it will be receive a score of $\alpha^n x$ points, where $\alpha = e^{-1/5} \approx 0.818730753$. The "number of days late", $n$, will be rounded up to the nearest integer. Thus a homework assignment worth 100 points at the start of Monday's class would be worth about

82 points if turned in immediately after class (or any time in the following 22.75 hours), or 55 points on Wednesday or 37 points on Friday, *et cetera*. This is a Cauchy sequence that converges (rapidly) to zero. It is in your best interest to keep up with the class and turn the homework in on time.
You are encouraged to discuss the problems with one another, but any work you turn in must be your own. If you find yourself having difficulty with the problems, please contact me to set up an appointment.

**Attendance:** Class attendance is expected. Some information will be announced only in class.

**Additional References:** There are many textbooks on probability theory ranging from introductory to advanced. Some of my favorites include Probability and Random Processes and by Grimmett and Stirzaker and Introduction to Probability by Grinstead and Snell. Another good reference for this course is
Intuitive Probability and Random Processes Using MatLab by Steven M. Kay. As of August 2016 it is available online from

`http://staff.on.br/puxiu/MatLab_Pack/`

**Topics:** The course will cover Chapters 1-8 of Ross, with additional topics from Chapters 9 and 10 as time permits.

**Chapter 1:** (Week 1) Combinatorial Analysis (the basic principle of counting; permutations; combinations; multinomial coefficients).

**Chapter 2:** (Week 2) Axioms of Probability (sample spaces and events; axioms of probability; sample spaces having equally likely outcomes).

**Chapter 3:** (Week 3) Conditional Probability and Independence (conditional probabilities; Bayes' formula; independent events)

**Chapter 4:** (Weeks 4-5) Random Variables (discrete RVs; expectation; variance; Bernoulli and binomial RVs; the Poisson RV; sums of RVs; cumulative distribution function)

**Chapter 5:** (Weeks 6-7) Continuous Random Variables (expectation and variance again; uniform RV; normal RV; exponential RV; functions of RV)

**Chapter 6:** (Weeks 8-9) Jointly Distributed Random Variables (joint distribution functions; independent RVs; sums of independent RVs; conditional distributions (discrete and continuous cases); order statistics; joint distribution of functions of RVs)

**Chapter 7:** (Weeks 10-11) Expectation (expectation of sums of RVs; moments of event counting functions; covariance, correlation, and variance of sums; conditional expectation; prediction; moment generating functions)

**Chapter 8:** (Weeks 12-13) Limit Theorems (Chebyshev's inequality; weak law of large numbers; central limit theorem; strong law of large numbers)

**Chapter 9:** (Time permitting) Additional Topics (Poisson process; Markov chains; entropy and information; coding theory).

**Computing:** Simulation methods (*cf.* Ross, Chapter 10) based on MATLAB will be used throughout the course, including as part of an *active learning* teaching approach. MATLAB is available on machines in the computer labs (e.g. NORD 4th floor lab). I recommend that you obtain a student copy of MATLAB. If you are new to MATLAB I recommend working through the introductory tutorials (available by typing `doc matlab` at the command prompt) before the first class meeting.