# Mathematics 4450/5450 - Applied Probability - Spring 2017

**Course description:** This course is about large collections of random variables, ones that have some interesting dependence between them. These are from random processes that play out over time or across space. The main goal of the course is to understand the nature of the structure that ties together these random variables in order to be able to model them and make decisions in the face of uncertainty. We will spend a relatively small amount of time developing the theory of random processes, and a relatively large amount of time trying to model real-world problems with tractable probabilistic models. We will develop theory as it becomes useful for working out the predictions of the models.

The main theoretical topics to be covered are: independence and conditional probability, Markov chains, Markov processes, Poisson processes, and Brownian motion. We will discuss applications to gambling, stock prices, inventory policies, queueing, and many other things. We will look for the "take-home lessons" in what we study.

**Course notes:** You may find it helpful to read lecture notes from earlier versions of the course. See `http://www-math.bgsu.edu/~zirbel/notes/math5450/`

**Programming:** You will be asked to read, run, edit, and write simple programs to simulate random processes. You can use whatever language you want, but R is recommended because it is free and widely used. If you don't know how to program, you can ask for help. Sample programs in R and Matlab may be found on Github at `https://github.com/clzirbel/Random_Processes`

**Text:** No required textbook. Recommended books are *Introduction to Stochastic Processes* by Erhan Çinlar and *Introduction to Probability Models*, 11th edition, by Sheldon Ross, 2014, Academic Press.

**Prerequisites:** A first course in probability theory like Math 4410/5410 is required, as is a first course in matrix theory or linear algebra like Math 3320. If your linear algebra is rusty, the main thing to practice is matrix multiplication and multipying a matrix on the left by a row vector.

**Coursework and Grading:** There will be two exams during the semester, a final exam, and weekly homework which will be graded. These will count 20%, 20%, 30%, and 30% respectively. A 90-80-70-60 grading scale will be used. Graduate students may have extra homework and exam problems to do.

**Related courses:** Math 3370, Differential Equations, models the evolution of systems in continuous time without the influence of randomness.

Stat 4160/5160, Time Series Analysis, is offered every spring. It focuses on stationary time series and modeling them as autoregressive and/or moving average processes, among other things.

Math 6440, Stochastic Processes, is offered in spring of even years. It covers Markov chains and Poisson processes in a more theoretical way than Math 4450/5450, and also renewal theory.

OR 6620, Probability Models for Decision Making, is offered in the spring of even years. It reviews probability, covers generation of random variables, Monte Carlo simulation, Markov chains, Markov decision theory, Markov processes, and topics in queueing theory.

Math 7410, Advanced Probability Theory I, is offered in fall of even years. It covers probability using measure theory. Specific topics are random variables, expectation, conditional expectation, limit theorems, and characteristic functions.

Math 7420, Advanced Probability Theory II, is offered in spring of odd years. It covers martingales in discrete time and Brownian motion in continuous time, with full rigor in all developments.