ECE-GY 6303: Probability and Stochastic Processes
Course Outline by lecture
(September 4, 2019 – December 20, 2019)

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Lecture Room/Time: 370 Jay St/Room 202/Wed 3.20-5.50PM

1. (9/4) Conditional Probability, Bayes' Theorem and Independent events; Random variables; Probability Distribution and density functions; Continuous and discrete random variables.
2. Functions of one Random Variable and their distributions; Expected value and Variances of a Random Variable; Characteristic Functions, Moment Generating Functions, and Higher Order Moments.
3. Joint distribution and density function of Two Random Variables; Independent Random Variables; One function of Two Random Variables and its distribution; Discrete Random Variables and their Functions.
4. Proability density functions (pdf) of One and Two Function(s) of Two Random Variables - Sum, Difference, Ratio, Product, Magnitude, Phase, Minimum, Maximum, Min/Max etc. – and their joint density functions; Jointly distributed Discrete Random Variables and their Functions

5. Covariance, Correlation, Orthogonality; Uncorrelated and Independent Random Variables; Joint characteristic functions and higher order Moments.
6. Jointly Gaussian Random Variables; Linear functions of Gaussian Random Variables and their joint density functions
7. Conditional distributions and conditional density functions; Conditional Mean and Variance; Conditional Gaussian Random Variables and their Mean and Variances
8. **Midterm Exam (Closed Book/Notes)**

9-10. Stochastic Processes; Concept of Stationarity; Strict Sense Stationary (SSS) and Wide Sense Stationary (WSS) Stochastic Processes; Auto correlation function and its properties; Examples: Poisson Processes; Probability Distributions of First and Second arrivals; Inter-Arrival distributions; Distributions of Poisson Arrivals within the Inter-Arrival/Departure Interval of another Independent Poisson Process(Geometric Distribution); Wiener Process.

11. Wide Sense Stationary Processes and their Autocorrelation Functions; Stationary Gaussian Process input to Memory-less systems. Discrete Time Processes.
12. Stochastic Inputs to Linear Time-Invariant (LTI) systems; Input-Output Autocorrelations; Differentiators; Probability of Zero-Crossing for Stationary Gaussian Processes.
13. Stationary Processes and Power Spectrum; Input-Output Power Spectrum for Linear Systems with Stochastic Inputs; Best Receiver: Matched Filter (MF), Optimization of Signal to Noise ratio (SNR) maximization.
14. Linear Estimation; Minimum Mean Square Error Estimation(MMSE) and Orthogonality Principle ; Equivalence of Best Estimator and best Linear Estimator for Discrete Gaussian Processes; Auto Regressive (AR), Moving Average (MA), and Auto Regressive Moving Average (ARMA), AR, MA Processes and their power spectra.
15. **Final Exam. December 18, 2019 (Closed Book/Notes)**

- **Prerequisites:** Good Undergraduate Probability course, sound calculus and some linear algebra.
- **Grading:** 10% Homework, 10% Quizzes, 35% Midterm, 45% Final.
- **Office Hours:** Noon-2PM, Day of class.
- **In-class Quizzes:** 5-10 minute quiz at the end of class.
- **Text Books:**
- A. Papoulis and S. U. Pillai, "Probability Random Variables and Stochastic Processes" 4th Edition, McGraw hill, NY 2001.
- **Lecture Slides:** http://www.mhhe.com/engcs/electrical/papoulis/ippt.mhtml
- **Videos**: https://www.youtube.com/channel/UC3I1RPdC7259bQZ8JWQYdrw
- **Other Books:**
- V. K. Rohatgi, "An Introduction to Probability Theory and Mathematical Statistics", John Wiley & Sons.
- V. K. Rohatgi, “Statistical inference,” John Wiley & Sons 1984.