THE UNIVERSITY OF WESTERN ONTARIO

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ECE 9035: Applied Probability Theory I: Introduction to Random Processes

Fall 2017 (MEng only)

PREREQUISITES:

SE2141b with average above 70% or equivalent, AM3415a, with average above 70% or equivalent, restricted to Electrical Engineering MEng Students specialized in Telecommunications or Control Theory.

OBJECTIVE:

The aim of the first part of the course is to introduce concepts of correlation theory for description of random processes to graduate student in the areas of electrical engineering and related disciplines. A number of concepts including random variable, random process, moment functions, characteristic function, transformation of random variables and processes and their moment functions are described.

EVALUATION:

Assignments 40%. During the semester a simulation project (30%) will be assigned to every student: a standard project will contain reading of a selected paper and writing a MATLAB code implementing some algorithms, described in this paper. Everybody is encourage to choose a project in the area of his/her interest. A written report and demonstration of related software will be required. A take home final exam (with oral defense) will contribute another 30%.

REFERENCE BOOK:

Papoulis, Athanasios, Probability, random variables, and stochastic processes , New York: Montreal : McGraw-Hill, c1991.

C.W. Gardiner, Handbook of Stochastic Methods for Physics, Chemistry and the Natural Sciences, Berlin: Springer, 1994, 442 p.

R. Risken, The Fokker-Planck Equation: Methods of Solution and Applications, Berlin: Springer, 1996, 472 p.

J.G. Kirkwood, Selected Topics in Statistical Mechanics, New York: Gordon and Breach, 1967, 266 p.

CONTACT HOURS:

3 lecture hours/week, 13 weeks, half course
The initial meeting for this course will be held place on _________ @ (Room, Time). The time for the further classes will be chosen to accommodate schedule of as many students interested in the course as possible. The final schedule will be posted as soon as possible after the first meeting but not later than 5 working days after it. Similar consensus arrangements will be made for the midterm (if applicable) and the final examination (if applicable).

TOPICS:

Introduction:

Deterministic and non-deterministic description of physical world. The various definitions of probability. Probabilistic experiments.

Part I. Basic Probability facts.

Independent events. Repeated trials. Bernoulli trials. Conditional Probabilities, Bayes' Theorem in Statistics.

Part II. Random variables and their transformation.

Distribution, density, conditional distribution and density. Moments of the distribution. Characteristic function. Cumulants. Function of random variable. Distribution of the random variable . Many random variables. Joint density and characteristic function. Moments and cumulants. Correlation. Transformation of a set of random variables.

Part III. Random Processes and their transformation

Definition and method of description. Stationarity and ergodicity. Transformation of the random processes. Moment functions and cumulant functions. Power spectrum densities and other higher order spectral functions. Wiener-Khinchin theorem. Narrow-band and wide-band random processes. Envelope. Relation between in-phase and quadrature components. Blanck-Lappierre transformation.

Part IV. Basic Random Processes

Normal (Gaussian) Random processes and Gaussian noise. Density and joint density.

Mean vector and correlation matrix. Wide-band and narrow-band random processes. White and coloured Gaussian noise. Brownian motion. Poisson Process and Shot Noise. Poisson distributions. Random Points in Time. Shot Noise. Densities.

Part V. Introduction to Markov processes

Markov property. Transitional density. Chapman-Kolmogorov equation. Markov chains. Transitional matrix. Stationary distributions. Numerical simulation of Markov chains.

Instructor: S. Primak (TEB 343)