THE UNIVERSITY OF WESTERN ONTARIO
FACULTY OF ENGINEERING
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ECE 9305: Applied Probability Theory I: Introduction to Random Processes
Fall 2018 (MESci and Ph.D. only)

PREREQUISITES:
SE2141b with average above 70% or equivalent, AM3415a, with average
above 70% or equivalent, restricted to Electrical Engineering Research Graduate 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 20%. During the semester a **research project** (60%) 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 exam** (with oral defense) will contribute another 20%.

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

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.

Part VI. Estimation, Prediction and their applications
Problem formulation and practical example. Linear prediction and regression. Applications of prediction in wireless communications.

Instructor: S. Primak (TEB 343)