THE GEORGE WASHINGTON UNIVERSITY
SCHOOL OF BUSINESS

DEPARTMENT OF DECISION SCIENCES
DNSC 8393: Applied Stochastic Models for Business
Time: Fall 2021, Thursdays, 3:30-600 pm
Instructor: Refik Soyer, Professor of Decision Sciences and of Statistics
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This doctoral course is designed to provide an in-depth coverage of stochastic models and their applications in business and industry. Starting with Bernoulli processes important concepts in stochastic processes are introduced and other processes are developed. Topics include: Poisson processes and its extensions including nonhomogeneous and compound Poisson processes, Markov chains, continuous time Markov processes, hidden Markov processes, Gaussian processes and Brownian motion, inference in stochastic processes. Applications to marketing, call center modeling, finance, queueing systems and operations will be presented using papers from applied probability literature. The course will consist of lectures and student presentations of selected problems from the text and examples from applied papers. A good amount of outside lecture reading is expected.

Course Learning Objectives:

(1) To provide students with an understanding of distribution theory for univariate and multivariate distributions.

(2) To develop student skills in calculus of probability.

(3) To provide an understanding of stochastic processes and main concepts such as stationarity, independent increments, conditional independence, etc.

(4) To develop an understanding of discrete and continuous time stochastic processes.

(5) To make an introduction to continuous time continuous state space processes.

(6) To present different applications of stochastic processes.

(7) To introduce computational issues in stochastic modeling.

Required Text: *Introduction to Probability Models* by Sheldon Ross, 10th or later edition, Academic Press.

List of Topics:
Review of Basics: Axioms of Probability
Conditional Probability and Expectation Computations
Introduction to Stochastic Processes: Bernoulli Processes
Poisson Processes and Extensions
Markov Chains and Applications of Markov Chains
Continuous Time Markov Processes
Introduction to Diffusion Processes
Gaussian Processes and Brownian Motion
Statistical Inference in Stochastic Processes
Applications
Other topics such as Renewal Processes and Markov Renewal Processes.

Tentative Course Outline
Session 1: Review of basics of probability. Random variables and probability models.

Session 2: More on Basics: Expectations of functions of random variables. Joint probability distributions. Covariance and linear dependence. Distributions of order statistics.

Session 3: Change of variable methods. Distributions of functions of random variables. Moment generating functions and their applications.

Session 4: Inequalities and Limit Theorems. Weak and strong convergence. Conditional probability distributions.

Sessions 5-6: Computing expectations and variances by conditioning. Conditioning for probability computations and its applications.

Session 7: Introduction to Stochastic processes. Bernoulli processes.

Session 8: Introduction to Markov Chains. Transient Analysis of MCs.

Session 9: Classification of States. Limiting analysis of MCs.

Session 10: Some computaions in MCs. Branching processes. Reversible MCs.

Session 11: Exponential Distribution. Poisson processes. Generalization of Poisson processes.

Session 12-13: Continuous Time Markov chains (CTMCs). Characterization and limiting properties. Computational issues.

Session 14: More on CTMCs. Introduction to Brownian motion (if time permits). Gaussian processes.

Assignment of Credit Hour Policy:

Students will spend 2.5 hours per week in class. Required reading for the seminar meetings and written papers or projects are expected to average 6 hours per week. Over the course of the semester, students will spend 35 hours in in instructional time and 85 hours preparing for class. Instructional time includes discussions and activities in class.

Grading:

Assignments and presentations	30%
Paper and presentation	30%
Final exam	40 %

Academic Integrity Policy:

Cheating and plagiarism will not be tolerated. Any case will automatically result in loss of all the points for the assignment, and may be a reason for a failing grade and/or grounds for dismissal. In case of a group assignment, all group members will receive a zero grade. Any suspected case of cheating or plagiarism or behavior in violation of the rules of this course will be reported to the Office of Academic Integrity. Students are expected to know and understand all college policies, especially the code of academic integrity available at: http://www.gwu.edu/~ntegrity/code.html

Special Considerations:

If a student has a special need, University policy states that the student must co-ordinate with the Office for Disability Services and present the course instructor with the appropriate documentation detailing the fair accommodations for the student. This policy is intended to ensure fairness for all students and privacy for the student with special needs. If you have a special need, please do not wait until after an exam or assignment to present the instructor with evidence of your need as consideration may not be given retroactively. The instructor ensures your privacy will be protected when accommodating special needs.

The University administration has accepted a resolution of the Faculty Senate regarding accommodations of religiously observant students and faculty. The requirements of this resolution state that students must notify faculty during the first week of the semester of their intention to be absent from class on their day(s) of religious observance. Faculty member will extend to these students the courtesy of absence without penalty on such occasions, including permission to make up examinations.