OPRE 7310 Probability and Stochastic Processes - Syllabus

Course Information
Course number - section: OPRE 7310 - 001; Course title - term: Probability and Stochastic Processes - Fall 2019. Lecture hours: 1:00-3:45 pm on W @ SOM 2.903.

Course Personnel
• Professor: Metin Çakanyıldırım, metin@utdallas.edu, SOM 3.408. Office hours: 5-6 pm on M @ SOM 3.408.
• Assistant: Abdullah Gökçınar, axg169230@utdallas.edu, SOM 3.228. Office hours: 11-1 pm on T @ SOM 3.228.

Pre-requisites
Calculus; or consent of the instructor.

Course Description
A large part of the course covers basic concepts and methods from the probability theory. Special attention is given to multivariate distributions and classification, comparison of random variables that are useful in modelling business processes. The later parts of the course cover a number of useful classes of stochastic processes including discrete-time Markov chains, Poisson process and Brownian process.

This course is mainly designed as a first-year graduate course in probability and with a consideration of the needs of a PhD student in Management Sciences. Master of Science students can also take this course provided that they have the pre-requisites. Especially current Master of Science students interested in pursuing their PhD degrees later are advised to take this course, which is a core course in many PhD programs.

In order to prepare students for research in Management Sciences, the course will have examples from different disciplines such as Operations Management, Information Systems, Marketing, Finance.

Course Objectives
• To introduce fundamental probability concepts.
• To illustrate these probability concepts with examples from Management Sciences.

Suggested Books
• To access a journal, go to the UTD Library web page www.utdallas.edu/library/ and click on “eJournals”.

Assignments & Grading Policy
• Students will be given +/- minus grades (e.g., A- or B+) based only on their mastery of the course material.
• 4% * Class attendance and contribution to discussion and notes.
• 28% * Homework: About 6 or 7 HWs will be assigned. You may discuss homework problems with others, but you must write up by yourself with the full understanding of what you write. Students handing in identical assignments will be violating university regulations and will not receive credit! Late homeworks are not allowed unless you get permission at least one day in advance of the due date.
• 34% * Midterm. Oct 9, Wednesday, in-class.
• 34% * Final. Dec 7, Saturday, starting at 10:00 am, location to-be-determined.
Tentative Course Topics

Module I: Introductory Probability: Defining Random Variables (RVs)

Events, Measurability, Independence
- Sample Spaces, Events, Measures, Probability
- Independence, Conditional probability, Bayes’ theorem

Random Variables
- RVs: Bernoulli, Binomial, Geometric, Poisson; Uniform, Exponential, Normal, Lognormal
- Expectations, Moments and Moment generating functions

Random Vectors
- Random Vectors: Joint and Marginal distributions, Dependence, Covariance, Copulas
- Transformations of random vectors, Order statistics

Module II: Intermediate Probability: Manipulating RVs

Conditioning RVs
- Conditional Distribution of a RV
- Computing probabilities and expectations by conditioning
- IT Application: Time-to-a-pattern for password security

Inequalities and Limits of Events, RVs, Distributions
- Inequalities: Markov, Chebyshev, Jensen, Hölder.
- Convergence of RVs: Weak and Strong laws, Central limit theorem, Distributions of extreme
- Marketing Application: Multinomial choice model

Classifying and Ordering RVs
- Increasing failure rate and Pólya densities
- Stochastic order, Hazard rate order, Likelihood ratio order, Convex order
- Marketing Applications: Concavity of profits

Module III: Stochastic Processes: Indexing RVs

Markov Chains
- Markovian property and Transition probabilities
- Irreducibility and Steady-State probabilities
- Generic Applications: Hidden Markov Chains

Exponential Distribution and Poisson Process
- Construction of Poisson Process from Exponential Distribution
- Thinning and Conditional Arrival Times
- Service Applications: Waiting Times

Normal Distribution and Brownian Process
- Construction of Brownian Process from Normal Distribution
- Hitting Times and Maximum Values
- Finance Applications: Option Pricing and Arbitrage Theorem

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1OPRE 7311 provides more discussion of Discrete-Time Markov Chains and Poisson Processes, and a coverage of Continuous-time Markov Chains, Renewal Theory, and Queuing Theory.