OPRE 7310 Probability and Stochastic Processes - Syllabus

Course Information
Course number - section: OPRE 7310 - 001; Course title - term: Probability and Stochastic Processes - Fall 2016. Lecture hours: 1:00-3:45 pm on W at SOM 2.802.

Professor Contact Information
- Professor: Metin Çakanyıldırım , metin@utdallas.edu , SOM3.408. Office hours: 5-6 pm on T at SOM3.408.

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 covers 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 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.

Required Materials:
- Introduction to Probability Models. Sheldon M. Ross. 11th edition published by Academic Press in 2014. Available from www.amazon.com. Chapters 1-5 and 10 are covered but chapters 6-9 are not.
- Course notes available from www.utdallas.edu/~metin/teaching.html with the password .....

Supplementary Books:
- Stochastic Processes. S.M. Ross. 2nd Edition. John Wiley & Sons 1996.
- Adventures in Stochastic Processes. S. Resnick. Birkhauser 1994.
- Comparison Methods for Stochastic Models and Risks. A. Müller and D. Stoyan. John Wiley & Sons 2002.
- Mathematical Theoy of Reliability. R.E. Barlow and F. Proschan. 1965. Re-published as a Classic in Applied Mathematics in 1996 by SIAM.
- 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.
- 10% * Class attendance and contribution to discussion and notes.
- 20% * Homework: About 5 or 6 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.
- 35% * Midterm. Oct 19 Wednesday, in-class.
- 35% * Final. Dec 14 Wednesday, location TBD.

Tentative Course Modules and Topics [1]

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

Chapter 1: Events, Measurability, Independence
- Sample Spaces, Events, Measures, Probability
- Independence, Conditional probability, Bayes' theorem

Chapter 2: Random Variables
- Random variables
- Discrete & Continuous RVs: Bernoulli, Binomial, Geometric, Poisson, Uniform, Exponential, Normal
- Expectations, Moments and Moment generating functions

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

Module II: Intermediate Probability: Manipulating RVs

Notes: Inequalities and Limits of Events, RVs, Distributions
- Inequalities: Markov, Chebyshev, Jensen, Hölder.
- Convergence in Probability and with Probability 1: Weak and Strong laws of large numbers
- Convergence in Distribution: Central limit theorem and Distributions of extreme

Chapter 3: Conditioning RVs
- Conditional Distribution of a RV
- Computing probabilities and expectations by conditioning
- Marketing and IT Applications: Multinomial choice model and Mean time to a pattern for password security

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

Module III: Stochastic Processes: Indexing RVs

Chapter 4: Markov Chains
- Markovian property and Transition probabilities
- Irreducibility and Steady-State probabilities
- Generic Applications: Hidden Markov Chains

Chapter 5: Exponential Distribution and Poisson Process
- Construction of Poisson Process from Exponential Distribution
- Conditional Arrival Times
- Nonhomogeneous and Compound Poisson Processes

Chapter 10: Normal Distribution and Brownian Process
- Construction of Brownian Process from Normal Distribution
- Hitting Times and Maximum Values
- Finance Applications: Arbitrage Theorem and Option Pricing

[1] OPRE 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.