OPRE 7310 Probability and Stochastic Processes - Syllabus

Course Information
Course number - section: OPRE 7310 - 001; Course title - term: Probability and Stochastic Processes - Fall 2020. Lecture hours: 1:00-3:45 pm on W @ MS Teams.

Course Personnel
• Professor: Metin Çakanyıldırım, metin@utdallas.edu, MS Teams. Office hours: 4:30-6 pm on M @ MS Teams.
• Assistant: Abdullah Gökçınar, axg169230@utdallas.edu, MS Teams. Office hours: 4:30-6 pm on T @ MS Teams.

Fall 2020 Announcements
• Instructional mode: Remote / Virtual on MS Teams platform.
• Asynchronous course access is “participating in the course not at the same time as the instruction of the course” according to https://utdallas.edu/covid/response/faq. Students can choose synchronous or asynchronous access. Synchronous / Asynchronous students have the same homeworks, exams and due dates.
• Class Recordings: Students are expected to follow appropriate University policies and maintain the security of passwords used to access recorded lectures. Unless the Office of Student AccessAbility has approved the student to record the instruction, students are expressly prohibited from recording any part of this course. Recordings may not be published, reproduced, or shared with those not in the class, or uploaded to other online environments except to implement an approved Office of Student AccessAbility accommodation. Failure to comply with these University requirements is a violation of the Student Code of Conduct at https://policy.utdallas.edu/utdsp5003.
• Class Materials: The Instructor may provide class materials that will be made available to all students registered for this class as they are intended to supplement the classroom experience. These materials may be downloaded during the course, however, these materials are for registered students’ use only. Classroom materials may not be reproduced or shared with those not in class, or uploaded to other online environments except to implement an approved Office of Student AccessAbility accommodation. Failure to comply with these University requirements is a violation of the Student Code of Conduct at https://policy.utdallas.edu/utdsp5003.
• Online tools: This course uses online tools for lectures and communication. Students can learn more about these tool at https://ets.utdallas.edu/elearning/students/current/tutorials. UT Dallas provides eLearning technical support 24 hours a day, 7 days a week. The eLearning Support Center includes a toll-free telephone number for immediate assistance (1-866-588-3192), email request service, and an online chat service.
• Distance Learning Student Resources: Online students have access to resources including the McDermott Library, Academic Advising, The Office of Student AccessAbility, and many others. Please see the eLearning Current Students webpage https://ets.utdallas.edu/elearning/students/current for more information.
• Server Unavailability or Other Technical Difficulties: The University is committed to providing a reliable learning management system to all users. However, in the event of any unexpected server outage or any unusual technical difficulty which prevents students from completing a time sensitive assessment activity, the instructor will provide an appropriate accommodation based on the situation. Students should immediately report any problems to the instructor and also contact the online eLearning Help Desk at https://ets.utdallas.edu/elearning/helpdesk. The instructor and the eLearning Help Desk will work with the student to resolve any issues at the earliest possible time.
• Academic Support Resources: The information contained at https://provost.utdallas.edu/syllabus-policies/academic-support-resources lists the University’s academic support resources for all students.
• Comet Creed: This creed was voted on by the UT Dallas student body in 2014. It is a standard that Comets choose to live by and encourage others to do the same:

“As a Comet, I pledge honesty, integrity, and service in all that I do.”
Pre-requisites
Calculus; or consent of the instructor.

Course Description
A large part of the course covers fundamental concepts and methods from the probability theory. Special attention is given to multivariate distributions, and convergence, classification and 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.

To prepare students for research in Management Sciences, the course will have examples from different disciplines such as Operations Management, Information Systems, Marketing, Risk Management and 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 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 from the course TA.
• 34% * Exam 1. Oct 14, Wednesday, TBD.
• 34% * Exam 2. Dec 2, Wednesday, TBD.
Tentative Course Topics

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

Events, Measurability, Independence
- Events in countable/uncountable sample spaces and measurement of their probability
- Monotone sets for exchanging limit and probability
- Independence; Conditioning; Bayes’ theorem

Random Variables
- Discrete RVs: Bernoulli, Binomial, Geometric, Poisson; Sum and limit of discrete RVs
- Continuity notions; Heavy Tail; Continuous RVs: Uniform, Exponential, Pareto, Normal, Lognormal
- 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
- Information Systems Application: Time-to-a-pattern for password security

Inequalities and Limits of Events, RVs, Distributions
- Inequalities: Markov, Chebyshev, Jensen, Hölder.
- Convergence of Sets, Probabilities and Distributions; Distributions of extreme
- Marketing Application: Multinomial choice model

Classifying and Ordering RVs
- Increasing failure rate and Pólya densities
- Sochastic order, Hazard rate order, Likelihood ratio order, Convex order
- Risk Applications: Risk comparisons with convex order

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

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.