جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Stochastic Processes - AMCS 241

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	AMCS 241
Course Title	Stochastic Processes
Academic Semester	Spring
Academic Year	2018/2019
Semester Start Date	01/27/2019
Semester End Date	05/23/2019
Class Schedule (Days & Time)	09:00 AM - 10:30 AM | Sun , 04:00 PM - 05:30 PM | Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
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Teaching Assistant(s)

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Course Information

Comprehensive Course Description	This course presents the fundamentals of probability theory and random processes. Contents of this course are relevant but not limited to: communications and information systems, computer engineering, signal processing, machine learning, bioinformatics, econometrics and mathematical finance. Contents: I- Quick Review of Probability 1- Introduction 2- Discrete Random Variables 3- Continuous Random Variables 4- Pairs of Random Variables 5- Multivariate Distributions 6- Multivariate Gaussian Random Variables II- Introduction to Random Processes 1- Definitions 2- Stationarity 3- Ergodicity 4- Correlation Functions 5- Gaussian Random Processes 6- KL Expansion 7- Some Continuous Time Random Processes (Bernoulli, Binomial, Poisson, Wiener, White, and Markov) III- Spectral Characteristics of Random Processes 1- Power Spectral Density 2- Cross Power Spectral Density IV- Analysis and Processing of Continuous Time Random Processes 1- Review of Linear Systems 2- Response of Linear Systems to Random Signals 3- Bandlimited Random Processes 4- Continuity, Differentiation, and Integration of Continuous Time Random Processes
Course Description from Program Guide	Topics include probability axioms, sigma algebras, random vectors, expectation, probability distributions and densities, Poisson and Wiener processes, stationary processes, autocorrelation, spectral density, effects of filtering, linear least-squares estimation and convergence of random sequences.
Goals and Objectives	AMCS 241 is an introductory graduate course. Students will learn the fundamentals of probability theory and stochastic processes. The main goal is for the students to thoroughly understand the covered topics and be able to apply them. The course prepares the students for more advanced and specialized courses.
Required Knowledge	**Prerequisites:** Adequate background in basic probability (including random variables and distributions), linear algebra, multivariate calculus, Fourier transform, z-transform and Laplace transform. Students should be competent in writing rigorous proofs and should understand terms such as ‘if and only if’, sufficient conditions, necessary conditions, etc. **Important note:** The course may be time-demanding, especially for those without the required background and mathematical fluency. A student who has deficiencies in his or her background can still take the course. However, the price will be more time spent on the course, or less acquired knowledge, or both. This course involves tutorial sessions and significant self-study and reading from handouts and references.
Reference Texts	**Textbooks:** Probability, Random Processes, and Statistical Analysis by H. Kobayashi, B. L. Mark and W. Turin. Textbook is available at: http://ebooks.cambridge.org/ebook.jsf?bid=CBO9780511977770 S. Kay, Intuitive Probability and Random Processes using Matlab, Springer, 2006. Available as E-BOOK at: https://link.springer.com/book/10.1007%2Fb104645 **References:** Geoffrey Grimmett and David Stirzaker, Probability and Random Processes, 3rd Edition, Oxford University press, 2001. (The exercises in the book are solved in another book by the authors titled One Thousand Exercises in Probability. This book has numerous solved exercises covering all the topics we do in AMCS 241.) Gallager, Stochastic Processes: Theory for Applications, Cambridge University Press, 2014. Sheldom Ross, Stochastic Processes, 2nd Edition, John Wiley & Sons, 1996. Papoulis, Probability, Random Variables, and Stochastic Processes, 4th Edition, Mc-Graw Hill, 2002. Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, 3rd Edition, Prentice-Hall, 2008. **Advanced References:** Patrick Billingsley, Probability and Measure http://www.colorado.edu/amath/sites/default/files/attached-files/billingsley.pdf Rick Durrett, Probability: Theory and Examples https://www.cambridge.org/core/books/probability/81949AABAA8B3A8411CB88402F0F05C9 David Williams, Probability with Martingales https://www.cambridge.org/core/books/probability-with-martingales/B4CFCE0D08930FB46C6E93E775503926 René L. Schilling, Measures, Integrals and Martingales https://www.cambridge.org/core/books/measures-integrals-and-martingales/7BEE19069C88A1376AEB988487D4131C

Method of evaluation	**30.00**% - Final exam **20.00**% - Quiz(zes) **25.00**% - Exam 2 **25.00**% - Exam 1
Nature of the assignments	1- Homework: Homework sets will be assigned early in the week and will be due in class on the following Sunday. Some homework assignments may require use any mathematical software of your choice (such as Matlab, Mathematica, Maple or Mathcad) for calculations and/or plots. Homeworks will not be graded but a tutorial session is organized on Thursday afternoon is organized to get some help/guidance from TAs. In addition the official solutions of homework will be provided over the weekend. 2- Exams: Weekly quizes + two exams + final exam are scheduled in class. The exams are closed books and closed notes. However, you are allowed to bring one sheet of notes, formulas, or any other information you would like to put on the page (no photocopy is allowed). This note sheet should be limited to one sheet of paper (8.5x 11 inches: A4 format) for the 1st exam. You can bring 2 such sheets for the second exam, and 3 such sheets for the third and final exam. The weekly quizzes have a duration of 20 minutes and will be held at the beginning of the Sunday lectures. The quizzes will be based on the homework problems and the examples covered during the lectures. 3- Grading: o Weekly Quizzes: 20 % o Exam 1: 25 % o Exam 2: 25 % o Final Exam: 30 % Grades will be posted on the course website.
Course Policies	-Late homework submissions are not accepted. - All exams are required. Students who do not show up for an exam should expect a grade of zero on that exam. - If you dispute your grade on any homework, or exam, you may request a re-grade (from the TA for the homework or from the instructor for the exams) only within 48 hours of receiving the graded exam. Incomplete (I) grade for the course will only be given under extraordinary circumstances such as sickness, and these extraordinary circumstances must be verifiable. The assignment of an (I) requires first an approval of the dean and then a written agreement between the instructor and student specifying the time and manner in which the student will complete the course requirements.
Additional Information	

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Sun 01/27/2019 Thu 01/31/2019	Chapter 0: Review of basic Math concepts
2	Sun 02/03/2019 Thu 02/07/2019	Quiz 1 Chapter 1: Basic probability theory + Combinatorics
3	Sun 02/10/2019 Thu 02/14/2019	Quiz 2 Chapter 2: Discrete random variables
4	Sun 02/17/2019 Thu 02/21/2019	Quiz 3 Chapter 3: Continuous random variables + Mixed random variables
5	Sun 02/24/2019 Thu 02/28/2019	Quiz 4 Chapter 4: Simulation of random variables Chapter 5: Probability bounds/inequalities
6	Sun 03/03/2019 Thu 03/07/2019	Exam 1 Chapter 6: Two random variables
7	Sun 03/10/2019 Thu 03/14/2019	Quiz 5 Chapter 7: Multiple random variables + Gaussian random vectors
8	Sun 03/17/2019 Thu 03/21/2019	Quiz 6 Chapter 8: Sum of random variables
9	Sun 03/24/2019 Thu 03/28/2019	Spring break
10	Sun 03/31/2019 Thu 04/04/2019	Quiz 7 Chapter 8: Sum of random variables (Continued)
11	Sun 04/07/2019 Thu 04/11/2019	Exam 2 Chapter 9: Introduction to random processes
12	Sun 04/14/2019 Thu 04/18/2019	Quiz 8 Chapter 10: Some important random processes
13	Sun 04/21/2019 Thu 04/25/2019	Quiz 9 Chapter 10: Some important random processes (continued)
14	Sun 04/28/2019 Thu 05/02/2019	Quiz 10 Chapter 10: Some important random processes (continued) Chapter 11: Processing of random processes
15	Sun 05/05/2019 Thu 05/09/2019	Quiz 11 Chapter 12: Markov chains
16	Sun 05/12/2019 Thu 05/16/2019	Review problems
17	Sun 05/19/2019 Thu 05/23/2019	Final exam

Note

The instructor reserves the right to make changes to this syllabus as necessary.