KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DEPARTMENT OF MATHEMATICS & STATISTICS
DHAHRAN, SAUDI ARABIA

STAT 416 : Stochastic Processes for Actuaries (122)

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Office Hours: Saturday: 8:00 am - 9:00 am, 12:05 pm - 1:05 pm.
Monday: 8.00am – 9.00am, 12.05pm - 1.05pm
Wednesday: 8.00am – 9.00am, 12.05pm-1.05pm or by appointment

Textbook:

1. Introduction to Probability Models, 10th edition, by Sheldon M. Ross (2012)

Course Objectives:

Basic classes of stochastic processes. Poisson (regular, compound, compound surplus, and non-homogenous) and renewal processes with applications in simple queuing systems and Actuarial Science. Discrete and continuous time Markov chains. Birth-Death and Yule processes. Branching models of population growth processes. Actuarial risk models; simulation. Arithmetic and geometric Brownian motions, and applications of these processes such as in computation of resident fees for continuing care retirement communities, and pricing of financial instruments.

Assessment
Assessment for this course will be based on attendance, homework, two major exams and a comprehensive final exam, as in the following:

Activity	Weight
Quiz , Homework and attendance	(12% + 6% + 2%)
Exam 1 (Chapters 1, 2, 3, 4) **Tuesday February 26, 2013 ,7pm, in Building 59**	20%
Exam 2 (Chapters 5, 6 & 7) **Tuesday April 23, 2013, 7pm, in Building 59**	20%
Final Exam (Comprehensive)	40%

***You need to achieve at least 50% in order to pass the course**

Academic Integrity: All KFUPM policies regarding **ethics** and **academic honesty** apply to this course.

Important Notes:

- ✓ Excessive unexcused absences will result in a grade of ***DN*** in accordance with University rules.
- ✓ ***Attendance*** on time is ***very*** important.
- ✓ *A formula sheet* and *statistical tables* will be provided for you in every exam.

Home Work:

- ➢ Handout problems will be posted on the WebCT or in the instructor home page towards the end of each chapter.
- ➢ The ***Homework*** should be submitted in the first Saturday after completing the chapter ***and no need for an announcement in advance***.
- ➢ No late homework will be accepted.

Syllabus (Tentative)

Week	*Sections*	**Topics**	*Notes*
Week 1 26/1 – 30/1	1.1-1.6	Basic concepts from probability theory (Review)	29 January
Week 2 2/2 – 6/2	2.1-2.9	Random Variables and Conditional probability	
Week 3 9/2 –13/2	3.1-3.7	Stochastic processes and introduction to the Markov chains	
Week 4 16/2 – 20/2	4.1-4.5	Markov chains	
Week 5 23/2 – 27/2	4.6-4.11	Markov chains – Branching Processes	
Week 6 2/3 – 6/3	5.1-5.3	The Exponential Distribution and The Poisson Process	
Feburary 26 - 1-st Major Exam **(chapters 1, 2, 3 & 4)**			
Week 7 9/3 – 13/3	5.4-6.4	The Poisson Process and Continuous-Time Markov Chains	
Week 8 16/3 – 20/3	6.5-6.8	Continuous-Time Markov Chains	
Midterm Vacation **March 23-27, 2013**			
Week 9 30/3 – **3/4**	7.1-7.5	Birth and Death Processes and Transition Probability Function	
Week 10 6/4 – 10/4	7.6-7.10	Queuing Theory-Exponential Models	
Week 11 13/4 – 17/4	8.1-8.6	Brownian Motion-Geometric Brownian Motion	
Week 12 20/4 – 24/4	8.7-9.3	Stochastic Models for stock prices and interest rates	
April 23 - 2-nd Major Exam **(chapters 5, 6 & 7)**			
Week 13 27/4 – **1/5**	9.4-10.3	Pricing Stock Options-The Arbitrage Theorem-Gaussian Processes	
Week 14 4/5 – 8/5	10.4-11.3	General Techniques for Simulating Continuous Random Variables	
15 11/5 – 15/5	11.4-11.8	Stochastic Processes- Simulating from Discrete Distribution	
Comprehensive Final Exam , May 16, 2013			

Learning objectives and outcomes:

On completion of the course the students will be able to:

Explain the concepts of probability.

- . Explain what is meant by a set function, a sample space for an experiment, and an event.
- Define probability as a set function on a collection of events, stating basic axioms.
- . Derive basic properties satisfied by the probability of occurrence of an event, and calculate probabilities of events in simple situations.
- . Derive the addition rule for the probability of the union of two events, and use the rule to calculate probabilities.
- . Define the conditional probability of one event given the occurrence of another event, and calculate such probabilities.
- . Derive Bayes' Theorem for events, and use the result to calculate probabilities.

Describe the properties of Poisson processes:

- For increments in the homogeneous case
- For interval times in the homogeneous case
- Resulting from special types of events in the Poisson process
- Resulting from sums of independent Poisson processes.
- For any Poisson process and the interarrival and waiting distributions associated with the Poisson process.
- Calculate: Expected values Variances Probabilities. For a compound Poisson process, calculate moments associated with the value of the process at a given time.
- Discuss the properties of the nonhomogeneous Poisson process.

Describe the properties of the exponential distribution:

- Discuss the properties of the exponential distribution.

Describe the properties of discrete and continuous Markov chains:

- For homogenous discrete-time Markov chain models: Define each model. Calculate probabilities of being in a particular state at a particular time.
- Calculate probabilities of transitioning between states.
- Explain what is meant by the Markov property in the context of a stochastic process.
- Define and apply a Markov chain.
- State the essential features of a Markov chain model.
- Applications of the Gambler's ruin problem.
- Markov chains Branching process.
- Hidden Markov Chains.
- State the features of the Continuous-time Markov chains.
- Discuss the features of the Birth and death processes.

- Demonstrate how Markov chains can be used as a tool for modelling and how they can be simulated.

- Describe a system of frequency based experience rating in terms of a Markov chain and describe other simple applications.
- Describe a time-inhomogeneous Markov chain model and describe simple applications.

Demonstrate the knowledge and understanding of Queuing theory.

- Discuss the steady state probabilities
- Discuss the applications of the Birth and Death Queuing Models.

Demonstrate a knowledge and understanding of stochastic models of the behaviour of stock prices.

- Discuss the continuous time log-normal model of security prices and the empirical evidence for or against the model.

Define and apply the main concepts of stochastic process Brownian motion (or Wiener Processes).

- Explain the definition and basic properties of standard Brownian motion or Wiener process.
- Demonstrate a basic understanding of stochastic differential equations, the Ito integral, diffusion and mean-reverting processes.
- State Ito's formula and be able to apply it to simple problems.
- Write down the stochastic differential equation for geometric Brownian motion and show how to find its solution.
- Show an understanding of simple stochastic models for investment returns.
- Discuss the applications of pricing stock options.
- State the Arbitrage theorem.
- Discuss the applications of geometric Brownian motion.

Describe the general techniques for simulating continuous random variables.

- Describe the generation of random variates from specified distribution.
- Discuss the inverse transformation method.
- Discuss the applications of acceptance and rejection methods.
- Disadvantages of using truly random numbers.
- Common sets of random numbers versus independent sets of random numbers.