ENG EC381 Probability Theory in Electrical and Computer Engineering

2008-2009 Catalog Data: Prereq: CAS MA 225. Introduction to modeling and analysis of uncertainty in electrical and computer systems. Experiments, models, and probabilities. Discrete and continuous random variables. Reliability models for circuits. Probability distributions. Moments and expectations. Functions of random variables. Sums of random variables and limit theorems. Signal detection and estimation. Discrete-time Markov chains. State-diagrams. Applications to statistical modeling and interpretation of experimental data in computer, communication systems. 4 cr.

Class/Lab Schedule:
Lecture-4 hours/week

Textbooks and other required materials:
Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers

Coordinator:
Professor David A. Castañón

Prerequisites by topic:
Multivariate calculus (CAS MA 225)

Goals:
This course introduces students to the basic concepts of probability and its applications in electrical and computer engineering. It provides them with an array of analysis tools and probability models that are commonly used in engineering applications. The students will also learn how to manipulate data and apply basic detection and estimation procedures.

Course Outcomes:
As an outcome of completing this course, students will:

i. Understand the basic concepts of probability.
ii. Feel comfortable with many of the standard probability models for random elements, both discrete and continuous
iii. Acquire a basic understanding of statistics.
iv. Understand the foundations of conditional probability with applications to signal detection and estimation.
v. Become familiar with applications of probability in electrical and computer engineering.
vi. Acquire the ability to use MATLAB to do analysis and simulation of random events
vii. Be prepared to succeed in follow-on specialized courses in discrete and continuous stochastic processes and statistics.

Course Outcomes mapped to Program Outcomes:

Program Outcomes	A	B	C	D	E	F	G	H	I	J	K
Course Outcomes	**i,ii,iii,iv**	**v,vi**	**iv, v**		**Iv,v, vi**						**iv,v, vi,vii**
Emphasis (1-5)	**5**	**2**	**2**		**3**						**3**

1=not at all; 5=a great deal;

Topics:

Foundations of Probability
– Set Theory, Probability Axiom, Conditional Probability, Counting
Discrete Random Variables (RVs)
– Probability Mass Functions (PMF), Cumulative Probability Distribution Function
– Important RV families and statistics, derived RVs
Continuous Random Variables
– Cumulative Distribution Function (CDF), Probability Density Function (PDF)
– Important continuous RV families and statistics, Gaussian RVs
Pairs of Random Variables
– Joint CDF, PMF and PDF functions, Expectation, covariance, crosscorrelation
– Joint Gaussian RVs and random vectors
– Conditional probability, Bayes' rule and conditional statistics
Detection Theory
– Binary Hypothesis testing, Maximum likelihood (ML), maximum aposteriori (MAP) and minimum Bayes risk detection, with applications: signal decoding, radar detection, multiple hypothesis classification
Estimation Theory
– ML, MAP, Minimum mean square error and linear least squares error estimation, with applications: signal denoising, parameter estimation
Limit Theorems
– Markov and Chebyshev inequalities, Strong and Weak Law of Large Numbers
– Central Limit Theorem and applications
Markov Chain
– Markov processes, transition probabilities, Chapman-Kolmogorov equation
– Classification of Markov chain states, irreducibility, ergodicity
– Characterization and computation of steady state probabilities with applications

Contribution of Course to Meeting the Professional Component:
Engineering topics: 100%

Status of Continuous Improvement Review of this Course:
Date Last Reviewed: **Reviewed by**:
December, 2005 DA Castañón, WC Karl & BE Saleh

Prepared by: David A. Castañón **Date**: June 22, 2009