ME 529 STOCHASTIC PROCESSES IN ENGINEERING
FALL 2009

INSTRUCTOR: G. Ahmadi, Room 102/267 CAMP (268-2322/6446)
Office Hours: TT 1 - 3:15 p.m.
TEXT: None
MAIN REFERENCE: A.Papoulis, Probability, Random Variables and Stochastic Processes, McGraw Hill.
COURSE SITE: **http://web2.clarkson.edu/projects/fluidflow/courses/me529/**

COURSE OBJECTIVE

- To provide the students with a fundamental understanding of probabilistic methods in engineering.
- To familiarize the students with the stochastic processes.
- To provide the students with the essential mathematical tools for handling random processes.
- To familiarize the students with the stochastic simulation techniques.
- To familiarize the students with the applications of probabilistic and stochastic methods in modern engineering problems.

COURSE LEARNING OUTCOMES

Objective 1: Students will be able to evaluate the statistical properties of random variables and can handle probabilistic transformations.

Objective 2: Students will become familiar with stationary and nonstationary stochastic processes, including Poisson, Wiener and white noise processes.
Students will be able to analyze linear stochastic differential equations with the use of spectral and correlation techniques.

Objective 3: Students will become familiar with Markov processes and Langevin equation.
Students will be able to formulate the Fokker-Planck equation for linear and nonlinear stochastic differential equations.
Students will be able to analyze nonlinear stochastic differential equations with the use of perturbation and equivalent linearization techniques.
Students will become familiar with the concept of stochastic stability.

Objective 4: Students will perform stochastic simulations in their respective fields of interest.
Students will become familiar with the applications of stochastic processes in engineering including random vibrations, turbulence, and related topics.

REFERENCES:

T.T. Soong, Random Differential Equations in Science and Engineering, Academic Press (1973).
J.L. Lumley, Stochastic Tools in Turbulence, Academic Press (1970).
S. Karlin and H.M. Taylor, A First Course in Stochastic Processes, Academic Press (1975).
C.V. Heer, Statistical Mechanics, Kinetic Theory and Stochastic Processes, Academic Press (1972).
A. Friedman, Stochastic Differential Equations and Applications, Vol. 1 and Vol. 2, Acacemic Press (1975).
R.L. Stratonovich, Topics in the Theory of Random Noise, Vol. 1 and Vol. 2, Gordon and Breach (1967).

S.H. Crandall and W.D. Mark, Random Vibration in Mechanical Systems, Academic Press (1963).
R.W. Clough and J. Penzien, Dynamics of Structures, McGraw Hill (1975).
H. Tennekes and J.L. Lumley, A First Course in Turbulence, MIT Press (1972).

COURSE OUTLINE:

Introduction to Theory of Probability
- Axioms of Probability, Probability Space, Repeated Trials
- Random Variables, Density and Distribution Functions
- Characteristic Function, Statistical Moments
- Function of Several Random Variables
- Probabilistic Transformation and Central Limit Theorem

Random Processes
- Introduction to Stochastic Processes
- Poisson Process, Wiener and White noise Processes
- Stationary and Nonstationary Processes
- Stochastic Calculus, Correlation and Power Spectra

Stochastic Differential Equations
- Linear System Analysis, Differential Equations with Random Forcing Functions
- Spectral Method for Stationary Systems, Nonstationary Response Analysis

Markov Processes
- Langevin's Equation and Brownian Motion
- Markov Processes, Ito's Equation
- Louiville and Fokker-Planck Equations
- Nonlinear Stochastic Systems
- Method of Moments of Fokker-Planck Equation

Nonlinear System Analysis
- Nonlinear Stochastic Differential Equations
- Perturbation Method
- Equivalent Linearization Technique

Random Systems
- Stochastic Differential Equations with Random Coefficients
- Stochastic Stability
- Introduction to Karhunen - Loeve Expansion

Applications
- Random Vibrations, (Cars on rough Roads, Earthquake Response of Structures)
- Reliability (Structures, engines, etc)
- Turbulent Fluid Flow
- Transport, Dispersion and Diffusion Processes

EVALUATION METHOD:
- Exam 1 (Wednesday, October 16) 25%
- Final Exam (Final Exam week) 40%
- Project (Due December 1) 25%
- Homework 10%