CE 408 — Risk Analysis
Fall 2003

Course Description: The role of risk and probability in Civil Engineering is described and basic probability concepts are presented. Probability distribution functions commonly used to model and analyze Civil Engineering problems are discussed. Methods for estimating parameters and determining distribution models from observational data are introduced. Monte Carlo simulation methods are practiced. Detailed examples of the application of probabilistic methods to structural, transportation, hydrological, and environmental system design are presented throughout the course.

Textbook: A.H-S. Ang and W.H. Tang, *Probability Concepts in Engineering Planning and Design, Volume I – Basic Principles*, Wiley, New York, 1975.

Topics:

1. Events and the mathematics of probability
2. Characterizing random variable distributions
3. Multiple random variables
4. Functions of random variables
5. Sample statistics, parameter estimation, and confidence intervals
6. Test if a distribution fits sampled data
7. Regression analysis

Course Objectives:

1. To study and analyze the probability of occurence of events in civil engineering problems
   Outcomes: The student will be able to:
   i) Express events in set notation and apply operations from set theory
   ii) Understand when events are mutually exclusive, collectively exhaustive, and statistically independent
   iii) Use conditional probability concepts to compute occurrence probability of correlated events
   iv) Use the Theorem of Total Probability and Bayes Theorem to compute occurrence probability
2. To study, analyze and apply random variables (RVs) governed by various distributions
   Outcomes: The student will be able to:
   i) Understand basic concepts characterizing RVs, such as statistics, density functions and so forth
   ii) Determine probabilities with Normal and Lognormal random variables
   iii) Determine probabilities and the relationship between Binomial- and Geometric-distributed RVs
   iv) Determine probabilities and the relationship between Poisson- and Exponentially-distributed RVs
   v) Solve problems involving multiple random variables
   vi) Characterize random variables that are functions of other random variables
3. To characterize random variables from sampled data
   Outcomes: The student will be able to:
   i) Understand and determine statistics of sampled data
   ii) Estimate the parameters of a distribution from sampled data
   iii) Determine confidence intervals from sampled data
   iv) Test the validity of proposed distribution for a set of sampled data
4. To study, understand and apply regression analysis to civil engineering problems
   Outcomes: The student will be able to:
   i) Understand and compute linear regression from sampled data
   ii) Estimate probabilities based on a regression analysis
   iii) Determine regression with multiple independent variables and with linear and nonlinear models
5. To use computer programming to solve and simulate random phenomena
   Outcomes: The student will be able to work in groups to:
   i) Use MATLAB® to simulate random phenomena (Monte Carlo simulation)
   ii) Use MATLAB® to determine probabilities in civil engineering problems

Class Schedule: 2 lectures (MW, 75 minutes each), 1 optional discussion (once per week, 50 minutes)

Laboratory: none

Computer Usage: four computer projects must be solved by student teams using MATLAB; this allows for exploration of the effects of varying parameters in real-world problems.

Relation of Course to Program Objectives:

The course provides the students with basic knowledge of probability and statistics, emphasizing the fundamental steps (*e.g.*, setup, analysis, solution, discussion) of engineering problems. It contributes to the following program outcomes:

A. To be able to identify, formulate and solve engineering problems.
C. To recognize the need for continuing life-long learning.
D. To apply the fundamental knowledge of science, mathematics and engineering principles.
E. To be able to use engineering skills and tools in engineering practice.
F. To be able to understand the impact of engineering solutions in a global and social context.
G. To be able to participate effectively on multi-disciplinary teams.
I. To be able to write effectively.
J. To be able to work with, and in specialized applications of, computers in the performance of job functions.

Contribution of Course to Meeting the Professional Component:

Engineering Topics: 2.5 units or 83% Engineering Design: 0.5 units or 17%

Prepared by: Erik A. Johnson Date: August 23, 2003