Instructor: Sharif Rahman, 2140 SC, 335-5679, rahman@engineering.uiowa.edu

Lecture: 9:30 - 10:45 am, TTH, 4030 SC

Prerequisites: Graduate standing; 58:113, 58:110 or 58:115 or equivalent.


References:

Course Info.: This course will expose students to state-of-the-art methods of stochastic mechanics and reliability analysis of mechanical and structural systems with uncertain material properties, geometry, and loads. Major topics include: basic concepts of probability theory; transformations of random variables and probability distributions; computational methods of structural reliability analysis; random eigenvalue problem; and random field and stochastic finite element method. Numerous applications from mechanical, aerospace, and structural engineering will be presented to illustrate methods of analysis and demonstrate the usefulness of stochastic methods in engineering.

A set of two-volume course notes will be made available to all registered students. The students will have the opportunity to write computer programs for the homework and research project. The instructor will provide commercial subroutines for finite element and reliability analyses to interface with the student’s own computer codes.
Major Topics Covered

A. Basic Concepts of Probability Theory
   • Basic probability concepts and axioms
   • Random variable, random vector
   • Probability density and distribution functions
   • Bivariate and $n$-dimensional random vector
   • Common probability distributions in engineering
   • Moments of random variable and random vector
   • Covariance matrix and correlation coefficient

B. Transformations of Random Variables and Probability Distributions
   • Transformation of random variables (linear and nonlinear systems)
   • First-order Taylor Series expansion and equivalent linearization methods
   • Transformation of probability distributions
   • One-to-one and general transformations involving one variable
   • Double integration for transformation involving two variables
   • Applications from various engineering disciplines

C. Computational Methods for Structural Reliability Analysis
   • Formulation of structural reliability problem for $n$-dimensional variables
   • First-order reliability method (FORM)
   • Second-order reliability method (SORM)
   • Random number generation
   • Independent and dependent random vectors
   • Monte carlo simulation
   • Advanced simulation methods
   • Applications from solid mechanics

D. Random Eigenvalue Problem
   • Eigenvalues and eigenvectors in uncertain systems
   • FORM/SORM and simulation methods
   • Perturbation methods for discrete systems
   • Perturbation methods for continuous systems
   • Probability bounds on eigenvalues and eigenvectors
   • Iteration methods
   • Applications from structural dynamics, structural stability, fracture mechanics

E. Random Field and Stochastic Finite Element Methods
   • Random process and random field
   • Discretization of random process/field
   • Midpoint and local averaging methods
   • Karhunen-Loeve expansion
   • Stochastic finite difference method
   • Stochastic finite element method
   • Perturbation and Neumann expansion methods
   • Applications from solid mechanics