CIVE 563 - STRUCTURAL RELIABILITY

Fall Semester 2015
TuTh 12:30pm – 1:45pm
Weber 202

Lecturer: Bruce R. Ellingwood
Engineering, Room A221
Office hours: Tuesday 3-5, or by appointment

Course Objective: To present concepts and applications of probability and statistics for the analysis of reliability and risk of structures subjected to natural and man-made hazards; to provide insights and perspectives on the use of these tools in engineering decision-making; and to establish a starting point for research in the field of structural reliability. Topics include stochastic modeling of structural strength and stiffness, loads and load combinations, reliability of structural elements and systems, time-dependent reliability, and probability-based codified design.

Week	Lecture Topic	Readings
(1) Aug 25	Basic probability theory; axioms, conditional probability, independence	M App A, D
27	Random variables and probability laws	B&C 2,3; A&T 2,3
(2) Sep 01	Functions of random variables; transformations of probability laws	A&T 4
03	Moments and expectation; moment-generating functions	M App C
(3) Sep 08	Common continuous probability laws	
10	Common discrete probability laws	
(4) Sep 15	Asymptotic extremes: Type I, II and III distributions	B&C 3.3
17	Review of statistical inference	B&C 4; A&T 6-8
(5) Sep 22	Basic analysis of structural safety; classical reliability theory.	M 1, 2
24	Classical reliability theory (cont'd)	
(6) Sep 29	Monte Carlo methods – random numbers, vectors	M 3, App E
Oct 01	Integral representation of Monte Carlo simulation; indicator functions	A&T 5
(7) Oct 06	Variance reduction techniques; importance sampling	
08	First-order (FO) reliability analysis	M 4.1-4.3
(8) Oct 13	First-order reliability - treatment of correlated random variables	M 4.4-4.7
15	First-order reliability - Rosenblatt, Nataf transformations	M App B, F
(9) Oct 20	System reliability; series and parallel systems	M 5.1-5.4
22	**Midterm examination**	
(10) Oct 27	Probabilistic models of system strength; structural fragilities	M 5.5-5.7
29	Review midterm examination	

(11) Nov 03 Time-dependent reliability; hazard functions. M 6.1-6.3
05 Time-dependent reliability – continuous and discrete load sequences

(12) Nov 10 Stochastic process models of structural loads – discrete models M 6.4- 6.6
12 Continuous load models; upcrossing analysis

(13) Nov 17 Load combination analysis M 6.7
19 Stochastic models of spatially distributed loads M 7

Nov 25 – 29 Thanksgiving break

(14) Dec 01 Probability-based codified design M 8, M9
03 Concepts of reliability-based optimization of life-cycle performance

(15) Dec 08 Stochastic fields
10 Introduction to stochastic finite element analysis

Wednesday, December 16th - Final examination: 9:40am – 11:40am

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Readings

(M) Melchers, R.E., *Structural reliability analysis and prediction*, John Wiley, 1999 [***Required text****]*

(B&C) J. Benjamin and C.A. Cornell, *Probability, Statistics and Decision for Civil Engineers,* McGraw-Hill, 1970.

(A&T) A. H.-S. Ang and W. Tang, *Probability Concepts in Engineering, 2nd edition*, John Wiley, 2007.

Selected papers from the attached reading list will supplement the lecture materials.

Grading

HW 25%, Midterm 25%, Final 50%

Teaching assistant

Derya Deniz (Glover 218) Hours: Monday, 2-4

Course Management

There will be nine homework assignments during the course of the semester. You are encouraged to discuss homework assignments among yourselves, as this is a good way to learn the material, but any work you turn in must be written in your own hand and be your own work. In-class tests and exams are to be your own work. Late homework will *not* be accepted without a *prior* excuse from me.

This is a research-oriented course. The reading list contains references that represent a diversity of noted authors and views and can be easily accessed. While I have not assigned specific readings from this list, you might find this material helpful as a starting point for further independent study.

Cell phones must be turned off and left in your pack during class.