Structural Reliability - Web course

COURSE OUTLINE

This web based course is mainly focused to explain the theories and applications of reliability analysis of structural systems having uncertainty and/or exposed to random environment. The course introduces basic concepts of probability theory at the beginning which is followed by the Level-2 reliability methods. The readers are then introduced to the intricacies of Monte-Carlo simulation and its advanced versions for variance reduction and subset simulation. The treatment of implicit limit states using RSM and recently developed SRSM techniques are explained separately with examples. With these knowledge of reliability analysis in hand, the course then aims to explain the applications of these methods for code calibrations and reliability analysis under multiple failure modes (i.e. system reliability). The time varying reliability analysis and reliability based optimization are then explained with example cases. A brief introduction of stochastic finite element is then provided. Finally, the course ends with example cases for reliability analysis of complex real life structures using MATLAB and commercially available software for finite element analysis like ANSYS in batch mode. The course will help the final year undergraduate students and/or post graduate students to develop their skills to take this subject for further research. As major emphasis is given to the applications, this course will also help the practicing engineers to use these advanced design concepts in their profession.

COURSE DETAIL

Sl. No.	Topic	No. of (Total) Hours
1	• Introduction Structural Reliability	1
2	• Basic Statistics • Theory of Probability • Probability Distributions (Continuous & Discrete) • Random Variables	6
3	• Level-2 Reliability Methods, Failure Surface & Definition of Reliability in Std. Normal Space (Cornell's Reliability Index), First Order Reliability Method (FORM) • Hasofer-Lind's Definition of Reliability • Rackwitz-Fiessler Algorithm • Asymptotic Integral, Second Order Reliability Method (SORM)	7
4	• Monte-Carlo Methods • Latin Hypercube Sampling, Variance Reduction Technique, Importance Sampling and Adaptive Sampling • Subset Simulation	7

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Civil Engineering

Additional Reading:

All relevant journal and conference papers

Coordinators:

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5	• Implicit Performance Function, Polynomial Response Surface Method (RSM) • Stochastic Response Surface Method (SRSM)	7
6	• Stochastic Models of Loads • Code Calibration, Partial Safety Factors, LRFD Format • System Reliability	5
7	• Time Varying Reliability Analysis	2
8	• Reliability Based Optimization • Introduction to Stochastic FEM	4
9	• Case Studies Using MATLAB & ANSYS in Batch Mode	3
Total Hours		**42**

References:

1. Papoulis A. Probability, Random Variables and Stochastic Processes, McGraw-Hill, New York, USA, 1991.
2. Ayyub B M, McCuen R H. Probability, Statistics and Reliability for Engineers and Scientists, Chapman & Hall, Florida, USA, 2000.
3. Ranganathan R. Structural Reliability Analysis & Design. Jaico Publishing House, Mumbai, India, 1999.
4. Melchers R E. Structural Reliability: Analysis and Prediction, John Wiley, Chichester, 1999.
5. Ang A H S & Tang W H. Probability Concepts in Engineering Planning and Design, Vol II, John Wiley, New York, 1984.
6. Madsen H O, Krenk S and Lind N C. Methods of Structural Safety, Prentice-Hall, Inc, Englewood Cliffs, USA, 1986.
7. Choi S K, Grandhi R V and Canfield R A. Reliability Based Structural Design, Springer-Verlag, London, UK, 2007.
8. Haldar A & Mahadevan S. Reliability Assessment Using Stochastic Finite Element Analysis, John-Wiely & Sons Inc., New York, USA, 2000.
9. Rackwitz R, Augusti G and Borri A. Reliability and Optimization of Structural Systems, Chapman & Hall, London, UK, 1995.
10. Waarts P H. Structural Reliability Using Finite Element Methods, Delft Univ. Press, Netherland, 2000.
11. Bucher C. Computational Analysis of Randomness in Structural Mechanics, CRC Press, London, UK, 2009.
12. Breitung K W. Lecture Notes in Mathematics, Springer-Verlag, Berlin, Germany, 1994.