Mechanical Engineering 573, Probabilistic Methods in Mechanical Design Spring 2002

Text: Reference: Probabilistic Mechanical Design, Edward B. Haugen, [John Wiley and Sons Publishers]

Classtime: MWF 13:30-14:30, LOW 206

Instructor: Prof. Michael Jenkins, 685-7061, jenkinsm@u.washington.edu
Office Hours: 09:30-11:20 MWF, MEB 305

Website: http://courses.washington.edu/mengr573/
Webstreaming: http://www.engr.washington.edu/edge/me573/me573vd.html

Week	Book Sections	Topic	Problems
Week 1			
01 Apr	Introduction + 1.1 to 1.3	Scope of Course	
03 Apr	1.3-1.5 + Notes	Traditional vs. Probabilistic Design	
05 Apr	2.1-2.4	Probability	HW #1
Week 2			
08 Apr	2.1-2.4 and Notes	Probability and Algebra of Probability	
10 Apr	2.5--2.9	Algebra of Expectation	
12 Apr		Algebra of Expectation	HW # 2
Week 3			
15 Apr	3.1-3.13	Load as a Random Variable	
17 Apr	3.1-3.13	Load as a Random Variable	
19 Apr	4.1-4.7	Component Geometry as Random Variables	HW # 3
Week 4			
22 Apr	5.1-5.20	Stress as Random Variables	
24 Apr	5.1-5.20	Stress as Random Variables	
26 Apr	6.1-6.10	Deflection as Random Variables	HW # 4
Week 5			
29 Apr	8.10-8.13	Mechanical Properties as Random Variables	
01 May	8.14-8.15 + Notes	Strengths as Random Variables & Random Processes	
03 May	9.1-9.3	Ductility, Toughness, Resilience, Hardness, Fatigue as RV	HW # 5
Week 6	PROJECT 1		
06 May	10.1-10.4 + Notes	Probabilistic Design and Analysis, Failure Theories	
08 May	10-5-10.8	Stress/strength Models, Fatigue	
10 May	10.8-10.11	Dynamic, Multi-axial, and Fracture	HW # 6
Week 7			
13 May	11.1	Reliability	
15 May	11.2	Confidence on Differences of Random Variables	
17 May	12.3	Confidence on Reliability	HW # 7
Week 8	PROJECT 2		
20 May	Notes	Design of Experiments	
22 May	Notes	Design of Experiments and Analysis of Exp. Results	
24 May	Notes	Analysis of Experimental Results	HW # 8
Week 9			
27 May	Memorial Day Holiday	N/A	
29 May	Notes	Risk Assessment	
31 May	11.1 to 11.5	Design Optimization	HW # 9
Week 10			
03 June	11.1 to 11.5	Design Optimization	
05 June	Class Notes / Handouts	Extra Topics	
07 June		Review / Final Preparation / Class Evaluations	

Comprehensive Final Exam: Monday, 10 June 2000, 14:30-16:20

Homework is due one week following assignment. Solutions will be available after the assigned homework has been turned in.

Grading: 50% Homework
25% Projects
25% Comprehensive Final

ME 573 Probabilistic Methods in Mechanical Design

OVERVIEW

General Description: Probabilistic Methods in Mechanical Design (3 Credits)

Study and implementation of probabilistic methods to design, primarily mechanical design. Course includes a review/introduction to probability, algebra of expectation, algebra of normal distributions, statistics of arbitrary functions, and random variables. Loading, component geometry, stress, and strain/deflection are described in terms of random variables and compared to material properties/behaviour in terms of random variables. Design, analysis, reliability, and risk assessment are conducted on common structures with results compared to conventional deterministic approaches. Student projects use probabilistic methods to optimize selected component designs.

Three 1-hr lectures/week

Course Goals: To give students (generally graduate standing) a basic understanding of the statistical nature of both component parameters as well as material properties and performance. The basic concepts are extended to 'real world' problems through class examples and student projects. Emphasis is placed on application to the optimization of engineering designs. Although emphasis is on mechanical design and structures, the concepts can be extended to other specialties in mechanical engineering (energy and fluids, and systems and dynamics).

Course Outline:

- Probability and Statistics Fundamentals
  - Probability Considerations
  - Algebra of Expectation
  - Algebra of Normal Distributions
  - Statistics of Arbitrary Functions
  - Exponential, Normal, Log Normal, Weibull, and Gamma Distributions
- Component Parameters as Random Variables
  - Loading (force and moment) Random Variables
  - Component Geometry and Stress Concentrations Random Variables
  - Stress Random Variables (effects of geometry, axiality, dynamics, mode)
  - Deflection Random Variables
- Materials Properties/Behaviour as Random Variables
  - Proportional Limit, Yield, Ultimate, and Fracture Tensile Strength Random Variables
  - Shear Strength Random Variables
  - Modulus of Toughness and Resilience as Random Variables
  - Fracture Toughness and Resistance as Random Variables
- Design, Analysis, Reliability and Risk Assessment
  - Classical vs. Probabilistic Approach to Mechanical Design
  - Monotonic and Fatigue Strength
  - Optimization of Mechanical Designs
  - Reliability and Confidence Intervals
  - Risk Assessment including fault tree analysis

Additional Reading

Reliability in Engineering Design, K.C. Kapur and L.R. Lamberson, John Wiley and Sons
Reliability Engineering in Systems Design and Operation, Blabir S. Dhillon, Van Nostrand Reinhold
Mechanical Survival: The use of reliability data, J.H. Bompas-Smith, MacGraw-Hill
Statistical Design and Analysis of Engineering Experiments, C. Lipson and N.J. Sheth, McGraw-Hill
Fatigue of Materials, Subra Suresh
Mechanical Behavior of Materials, Thomas Courtney
Mechanical Engineering Design, Joseph Shigley and Larry Mitchell
Stress, Strain, and Strength, Robert Juvinall

Related Courses

ENGR 315, "Introduction to Probability and Statistics"
STAT (MATH) 390, "Probability and Statistics in Engineering and Science"
STAT (MATH) 394, 395, 396, "Probability I, II, and III"
IND E 316,"Regression Analysis and Design of Experiments"
IND E 420,"System Safety and Reliability Engineering"
CESM 523, "Reliability and Design
EE 505, "Introduction to Probability and Random Processes"
EE 508, "Stochastic Processes"
IND E 526, "Reliability in Product Design and Testing"
ME 566, "Random Processes"