CEE 289: Random Vibrations

Course information: 3:15 – 5:05 pm, Tuesday and Thursday
Y2E2 Room 111

Instructor:
Jack Baker
Y2E2 Building, Room 283
650-725-2573
bakerjw@stanford.edu
Office hours: Tu, Th 1–2:30 pm or by appointment

Teaching assistant:
Christophe Loth
Office: Building 540, Room 206
lothc@stanford.edu
Office hours: M, W 1–2:30 pm

Course website: coursework.stanford.edu

Introduction and Prerequisites

This course is designed to introduce advanced graduate students to concepts of random vibrations for dynamic analysis of structural and mechanical systems subjected to stochastic loading. CEE 203 and CEE 283, or their approved equivalents, are required prerequisites. This course is more theoretical in nature than CEE 203 and is intended for PhD students working with probabilistic methods, but interested MS students with the necessary prerequisites are welcome to enroll.

Course topics and learning objectives

Students taking this course will learn to apply tools from probabilistic modeling to analyze dynamic systems while accounting for variability and uncertainties that are inevitably present in real engineered systems. By the end of this class, you will be able to:

- Classify random excitations as stationary or non-stationary
- Discuss important properties of random processes
- Define and compute power spectral density functions
- Compute auto-and cross-correlation functions, and relate them to power spectral density functions
- Describe the dynamic response of a multi-degree-of-freedom system to a stochastic excitation
- Quantify the distributions of peak loads and peak responses from a system subject to stochastic excitation

Textbook

Loren D. Lutes and Shahram Sarkani (2004) *Random Vibrations: Analysis of Structural and Mechanical Systems*, Elsevier Butterworth-Heineman.

This textbook is available electronically from within the Stanford campus:
http://www.sciencedirect.com/science/book/9780750677653

This textbook is listed as required, because I will be assigning homework problems from it. It should be useful for those of you looking for an alternate presentation of the course material, and will serve as a valuable reference book in the future.

Evaluation

You will be evaluated on your ability to explain the course concepts and perform calculations using the techniques presented in class. Grades will be computed using the following weighting scheme:

Homework	30%
In-class exam: date to be determined	30%
Project presentation	10%
Project report	30%

Homework assignments will consist of calculations and derivations related to the material presented in class. The exam (roughly 2/3 of the way through the course) will be similar to the homework in content and format. The course will conclude with a project where students (optionally working with a partner) will apply course concepts to a research topic or application that they identify.

Homework policy

- Homework assignments are to be submitted at the beginning of the lecture period on the date due.
- Late assignments will be penalized at a rate of 10% per day late. Homework submitted after the solutions have been provided will not be accepted. Exceptions to this policy may be arranged with Prof. Baker for special situations such as a serious illness.
- Some homework assignments will require computer calculations. Matlab will likely be the easiest tool for performing these calculations, and is the software package that will be supported by the instructor and teaching assistant. You are free to use another program such as Excel or C if you prefer, as long as you clearly document what you have done.

Honor code

It is expected that Stanford's Honor code will be followed in all matters relating to this course. You are permitted to meet and exchange ideas with your classmates while studying and working on homework assignments, but you are individually responsible for your own work and for understanding the material. You are not permitted to copy or otherwise reference another student's homework or computer code.

Tentative schedule (subject to change)

Date	Topic	Suggested reading
3/29	Intro and review of prob.	2, 3
3/31	Characterization of stochastic processes	4.1-4.5, 4.7, 4.10
4/5	Characterization of stochastic processes	
4/7	Stochastic calculus	4.6, 4.8, 4.9
4/12	Stochastic calculus	
4/14	Deterministic dynamics	5.1, 5.2, Chopra
4/19	Freq domain stochastic processes	Appendix B
4/21	Freq domain stochastic processes	6.1 - 6.5
4/26	Freq domain stochastic processes	
4/28	Freq domain structural response	6.6, 6.8
5/3	Bandwidth estimates, etc.	
5/5	Midterm (date not confirmed)	
5/10	Bandwidth, example data	
5/12	Estimating PSD from data, example data	11
5/17	Reliability under random vibrations	
5/19	CQC derivation	8, Chopra
5/24	CQC derivation	
5/26	Student presentations	
5/31	Student presentations	