Ottawa – Carleton Institute for Civil Engineering, University of Ottawa Campus
CVG 5154 - Random Vibrations
Winter 2011

Objectives
Descriptions of random data. Frequency domain analysis and time domain analysis.
Stochastic response of structures; wind and earthquake excitation, etc. Data analysis
techniques. Prediction for design purposes. Simulation of random processes. Special
topics.

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Lectures
26 lectures
Tuesday, 17:30 - 20:30 CBY D103

Evaluation
Four Assignments 70%
Final exam 30%

Course Content
1. INTRODUCTION
   Random vibrations of structures
   Concept of spectral analysis

2. MATHEMATICAL BACKGROUND
   Elements of statistics and probabilities
   Fourier transformation

3. STRUCTURAL DYNAMICS
   Dynamics of SDOF, MDOF and distributed mass systems
   Time domain and Frequency domain analyses

4. STOCHASTIC RESPONSE OF DYNAMIC SYSTEMS
   Mathematical formulation of analyses
   Stochastic models of physical phenomena
   Wind excitation of structures - practical application

5. TIME SERIES AND FAST FOURIER TRANSFORMATION

6. EXTREME VALUES ANALYSIS

7. SPECIAL TOPICS

Comments
The use of software (Matlab, Fortran) is highly recommended. The software is available at
Computing network of Faculty of Engineering.

IMPORTANT: Announcements, updates and eventual modifications will be posted on the Blackboard
Vista link of the course. Also assignments marks and grading will be available through the
same link. Often checking of course link is recommended.

Information about academic fraud (found at this link:
Please take note that although the academic fraud regulations webpage dates back to 2003-
2005, the regulations have remained the same and still apply.
Chapter 1  Introduction

1.1  Random Vibration of Structures
1.2  Concept of Spectral Analyses

Chapter 2  Basic Tools in Statistics

2.1  Statistics and Probability of Random Variables

Essential probability
Statistics of a random variable
Statistics of two time series

2.2  Harmonic Analysis
2.3  Spectra and Correlation Functions
2.4  Wavelet Analysis
2.5  Commonly Used Probability Distributions

Models based on simple discrete random trials - Binomial distribution
Models based on random occurrences - Poisson distribution
Normal or Gaussian distribution
Other normal-related distributions

Chapter 3  Elements of Structural Dynamics

3.1  Introduction
3.2  Dynamics of SDOF Systems
3.3  Lateral Vibration of Elastic Beams
3.4  Numerical Integration Methods
3.5  Dynamics of MDOF Systems

Complex eigenvalue problems
Forced vibration
TMD - An example of TDOF systems

3.6  Some Notes on Damping

Nature of vibration damping in general
Sources of damping
Artificial dampers
Protection of human bodies from vibration effects
Other criteria related to socio-economic impacts

Chapter 4  Stochastic Response of Dynamic Systems

4.1.  SDOF Systems
Response to a single random loading
Response to multiple random loadings
4.2. Response of Elastic Structure to a Distributed Random Load

4.3. Wind Excitation of Structures

General characteristics
Analytical prediction
Aerodynamic admittance
Peak factor
Time domain analysis

Chapter 5 Data Analyses

5.1. Statistical Treatment of Discrete Time Series

Digital data
Trend removal
Statistical functions for a discrete process

5.2. Fourier Analysis

Discrete Fourier Approximation
Nyquist frequency
Parseval's theorem
Complex expression of Fourier coefficients

5.3. Fast Fourier Transform Technique
5.4. Power Spectra and Auto-correlations
5.5. Spectral Windows
5.6. Errors Associated with Spectral Analysis

Chapter 6 Extreme Value Statistics

6.1 Probability Distribution of Extreme Values
Estimation of extremes from parent population
Extreme value distributions

6.2 Probability of Threshold Crossing

Probability of up-crossing / level crossing
Probability density of the peaks
Probability density of the envelope

6.3 Structural Design against Yield and Fatigue

Structural failure due to yield
Structural failure due to fatigue
Cycle counting

Chapter 7 Simulation of Random Processes

7.1 Monte Carlo Method
7.2 Stationary Gaussian Random Processes
7.3 Non-stationary Gaussian Random Processes
7.4 Random Pulse Train Processes
7.5 Multi-Variate Random Processes

Chapter 8 Nonlinear Vibration
8.1 Introduction
8.2 Numerical Integration Techniques
8.3 Nonlinear Random Vibration

Fokker-Planck Equation Perturbation Method
Equivalent Linearization Method

References:


