Seoul National University
Dept. of Civil and Environmental Engineering Instructor: Junho Song (junhosong@snu.ac.kr)

FALL 2018
457.643 Structural Random Vibrations
TuTh 15:30-16:45, 428 Bldg. 38
Instructor: Junho Song

Prerequisites: 457.516 Dynamics of Structures

Course Objectives:

Application of probabilistic methods in describing and defining loads on structures with emphasis on the random fluctuation in time. Introduction to theories of stochastic processes, random vibration methods and applications to dynamic response of structures under earthquake loads. Computer simulation of structural loads and responses.

Course Website: http://etl.snu.ac.kr

Important Dates:

- September 4: Class begins
- September 25: Thanksgiving holiday (no class)
- October 9: Hangeul Day (no class)
- Midterm exams: (tentatively) October 30 and November 29 (in class)
- Last class: December 13
- Oral exam and term project report submission due: December 19

Credit: 3 hours

Textbooks:

[Main] Lutes, L.D., and S. Sarkani (2004). *Random Vibrations: Analysis of Structural and Mechanical Systems.* Elsevier Butterworth-Heinemann, Burlington, MA.

Newland, D.E. (2005). *An Introduction to Random Vibrations, Spectral & Wavelet Analysis*, 3rd Ed., Dover Publications, Mineola, NY.

Wirsching, P.H., T.L. Paez, and K. Ortiz (2006). *Random Vibrations: Theory and Practice*. Dover Publications, Mineola, NY.

References: Selected references will be listed at the course website or distributed by emails.

Homework:

Weekly assignments will be given on most Thursdays. Turn them in during class in a week. Late homework submission is not allowed unless the advisor approves. Students are encouraged to use computer programs such as Matlab® but should show the procedure clearly and submit the codes if they are needed to explain the procedure.

Grading:

Homework: 30 %, Midterm exams: 40 %, Final term project and oral exam: 30 %

Instructor: Prof. Junho Song
Room 403 Bldg. 35, E-mail: junhosong@snu.ac.kr
URL: http://systemreliability.wordpress.com/
Office hours: Q&A after each class or by appointments

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Course Outline

I. Basic Elements ~ Review on basic theories of probability.

II. Introduction to Random Process

II-1. Random processes
- Definition
- Average, statistical moments and second-moment functions
- Stationary process
- Special processes – Poisson process; Gaussian (normal) process

II-2. Stochastic calculus
- Continuity; Differentiability; Mean-square integration
- Second-moment function properties
- Power spectral density function; Spectral moments; Ergodicity

III. Random Vibration of Linear Structures

III-1. Response functions
- Impulse response function
- Frequency response function

III-2. Random vibration analysis of linear structures
- Time-domain analysis
- Frequency-domain analysis
- Stationary and nonstationary responses
- State-space formulation

IV. Random Vibration of Multi-Degree-Of-Freedom Systems

IV-1. Non-modal approaches
- Time- and frequency-domain analysis; State-space formulation

IV-2. Modal approach
- Modal cross-correlations; Modal combination rules (CQC)
- Random vibration analysis by use of spectrum

V. Crossings and Failure Analysis of Stochastic Systems

- Crossing rates; Distribution of local/extreme peaks; First passage probability
- Stochastic analysis of fatigue (accumulated damage)

VI. Nonlinear Random Vibration Analysis

- Equivalent linearization methods
- Applications to nonlinear SDOF/MDOF systems, e.g. Bouc-Wen hysteresis models
- Random vibration analysis by structural reliability methods; tail equivalent linearization method (TELM, Fujimura and Der Kiureghian 2007)
- Gaussian mixture based ELM (Wang and Song 2017, Yi et al. 2018)