CE 70250: Experimental Methods in Structural Dynamics
Spring 2013
University of Notre Dame
Department of Civil Engineering & Geological Sciences

Course Description: This course overviews experimental techniques for analyzing the behavior of structures under dynamic loads. Course includes vibration measurement through experiments, signal processing and system identification. Experimental modules on modal testing, acceleration-based system identification, and damage detection are provided. This special offering will allow a more informal venue to explore this subject in a project-based format personalized to the student's research interests and needs.

Course Objectives: By the end of the semester, students will be able to:

1. Have a basic understanding of structural dynamics and random processes concepts central to interpreting experimental data
2. Have a working knowledge of signal processing issues of relevance to experimental structural dynamics, with particular emphasis on those associated Sampling Theory and implementation of Fourier Transforms
3. Be able to specify requisite sensors, excitation types and data acquisition settings for a specific application, including the execution of small scale experiments simulating various scenarios in modal testing
4. Be able to apply and interpret the outcomes of frequency and time-frequency analyses applied to experimental data, including data they collect in small scale experiments
5. Be able to identify classes of system identification techniques appropriate for a given application
6. Be able to execute common system identification approaches in the time and frequency domain using experimentally acquired data
7. Be able to interpret findings and present information to client/end user.

Lectures: MW 11:45 am - 1:00 pm, 244 DeBartolo Hall

Instructor: Dr. Tracy L. Kijewski-Correa (Dr. K.C.)
162 Fitzpatrick Hall
Office: 631-2980, Mobile: 574-220-3679
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Office Hours: Tuesdays, 3-5 pm or by appointment

Course Laboratory:	DYNAMO Laboratory, 107 Cushing Hall (keys may be obtained from Mollie Dash)
Course Website:	sakai.nd.edu: all resources, lectures, assignments and solutions will be posted to this site. Hardcopies will not be distributed in class.
Office Hours:	Tuesdays, 3-5 pm or by appointment 162 Fitzpatrick Hall
Referenced Texts:	*Random Data: Analysis and Measurement Procedures* J. Bendat, A. Piersol *The Encyclopedia of Vibration* S. Braun, D. Ewins *Harris' Shock and Vibration Handbook* C. Harris, A. Piersol *Structural Sensing, Health Monitoring, and Performance Evaluation* D. Huston *Structural Health Monitoring of Civil Infrastructure Systems* V.M. Karbhari
Credits:	3.0 Credit Hours (Lecture)
Attendance:	Lecture attendance is not required, though regular attendance is highly correlated with student success in this class.
Assignments:	Unless instructed otherwise, all assignments are to be typewritten. Hand calculations may be submitted as appendices. Multi-page assignments should be stapled or otherwise bound. Final answers to calculations should be clearly designated, e.g., boldface, underlined or boxed. Any assignment received after the due date will have a 10% reduction in the possible score for each day late.
Examinations:	There will be one midterm examination and one final examination in this course. Individuals with unexcused absences for these exams will be given a zero grade. Students will receive instruction on the format and length of allowed materials for use in the exam.
Honor Code:	The Notre Dame Academic Code of Honor Pledge expects students to abide by it. "As a member of the Notre Dame community, I will not participate in or tolerate academic dishonesty." Please see http://nd.edu/~hnrcode/docs/handbook.htm

for more details on the honor code. The professor's interpretation of these policies is as follows:

- In the context of individual homework, students are allowed to discuss and work with classmates, however all homework turned in for credit should be one's own. If close collaboration was utilized, students should indicate the name of the collaborator.
- Many laboratory assignments will be executed in pairs. It is expected that both team members will contribute equally, turn in one assignment and receive the same grade for that assignment. Teams may discuss the assignment with other teams, but again should conduct and hand in their own work.
- Of course, all work on examinations and finals shall be the student's own.

Target Audience: Graduate elective for structural engineers though content may be of interest for aerospace/mechanical engineers or others with interest in signal processing, data acquisition and inverse problems for mechanical systems.

Pre/Co-Requisites: Structural Dynamics/Random Vibrations or equivalent, Introductory Probability/Statistics

Grades:

Midterm Examination	25%
Lab Assignments/Projects	25%
Individual Homework	25%
Final Examination	25%
	100%

Midterm Examination: March 6, 2013 (in class)

Final Examination: Comprehensive, May 7, 2013, 4:15 pm -6:15 pm
Location: TBD

COURSE COVERAGE

Step	Date	Lecture	Topic	Assignment
Intro	1/16	1	Course Introduction	Problem Def.
1	1/21	2	Presentation of Case Studies	Lit. Review
2	1/23	3	Physics-Based Models	MATLAB Exercises, Project Application
4	1/28	4	Direct Data Interpretation I	
4	1/30	5	Direct Data Interpretation II	
4	2/4	6	Signal Processing Issues in Random Data I	MATLAB Exercises, Project Application
4	2/6	7	Signal Processing Issues in Random Data II	
3	2/11	8	Signal Processing Issues in Fourier Transforms	
3	2/13	9	Data Acquisition Considerations	Sensor and Excitation Application (Lab), Project Application
3	2/18	10	Excitation Sources	
3	2/20	11	Sensors: Accelerometers, Load Cells	
3	2/25	12	Sensors: Global Displacements	
3	2/27	13	Sensors: Local Displacements	
3	3/4	14	Modal, Impact Testing	
	3/6		MIDTERM EXAM	
	3/11		SPRING BREAK	
	3/13		SPRING BREAK	
5	3/18	15	System Identification	Full-Scale Data Analysis
5	3/20	16		
5	3/25	17		
5	2/37	18		
	4/1		EASTER BREAK	
5	4/3	19	System Identification	Laboratory Experiment
5	4/8	20		
5	4/10	21		
5	4/15	22		
6	4/17	23	Decision Making	Laboratory Experiment
6	4/22	24		
6	4/24	25		
6	4/29	26		
	5/1		Project Presentations	
	5/7		FINAL EXAM	