560.630: Structural Dynamics
Spring 2016

Pre-requisites: ODEs, linear algebra, rigid-body dynamics, static analysis of structures
Credits: 3
Lectures: MW 12-1:15pm
Room: Krieger 309

Instructor: Prof. Judith Mitrani-Reiser, *jmitrani@jhu.edu*
Office Hours: Fri 10am-12pm and by appointment, Latrobe 202 (Ext 6-7763)

TAs: Guanbo Bian, *bian@jhu.edu*
Office Hours: MW 6-7pm and by appointment, Latrobe 17.

Blackboard: https://blackboard.jhu.edu (Login using JHU Enterprise Authentication)

Description: Functional and computational examination of elastic and inelastic single degree of freedom systems with classical and non-classical damping subject to various input excitations including earthquakes with emphasis on the study of system response. Extension to multi-degree of freedom systems with emphasis on modal analysis and numerical methods. Use of the principles of structural dynamics in earthquake response.

Objectives: (1) Use mathematical models to *describe* structural response induced by dynamic excitation, emphasizing insight into the properties of real structures.
(2) Apply principles of structural dynamics and interpret theoretical and numerical results to better understand seismic behavior and the design of buildings.
(3) Students will learn to think critically through in-class problem solving exercises, including round-robin and other group activities.
(4) Students are expected to apply modern engineering tools to identify, formulate, and execute engineering solutions as well as communicate their results through their term project and formal in-class presentation of their results.

Textbook: Chopra, A.K., 2007. *Dynamics of Structures: Theory and Applications to Earthquake Engineering*, 4th edition, Prentice-Hall.

Software: MATLAB by MathWorks (http://www.mathworks.com/products/matlab/)

Access: http://hub.jhu.edu/announcements/2014/07/09/free-matlab-to-students-faculty-staff-beginning-august-1-2014

Grading: A weighted average will be calculated as follows:

Homework (8)	20%
Midterms (2)	40%
Final Project	40%

Note that I will automatically drop your lowest homework grade. The course grades will be determined as follows:

Score	>97	93-96.9	90-92.9	87-89.9	83-86.9	80-82.9	77-79.9	73-76.9	70-72.9	67-69.9	63-66.9	60-62.9	<60
Grade	A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F

Homework: Homework contributes to 20% of your final grade. **HW assignments are due at 5pm** on the given date, and should be dropped off in the box outside my office. Any homework assignments turned in late will be penalized with a 50% deduction. No exceptions will be made for deduction of late assignments, and so the lowest homework grade will be dropped. If you believe an error was made in grading the homework, you should write a short justification of your claim and attach it to the original homework assignment in question and return it to the instructor in class or in the mailbox outside her office. The TA or instructor will review your concern and respond to you directly. The "statute of limitations" for submitting such claims is one week after the homework is returned.

Homework Guidelines: Homework (8 assignments) contributes to 20% of your final grade. Homework assignments that are solved by hand must be submitted on engineering computation paper. Your name, class title (e.g., 'Structural Dynamics'), and solution page number (e.g., '1/10', …, '10/10') must appear on every page of your solutions. Additionally, the first page of your solutions should include the number of hours taken to complete the assignment and the name of any classmates that worked with you on the homework assignment. Any time that MATLAB is used in a homework assignment, you should include a **printout** of the most relevant parts of your script file, clearly identifying any input/output used by your program. Additionally, any relevant m-files and dat-files shall also be **emailed** to the Professor and TA(s), with the name of the homework assignment (e.g., 'Homework #7') written on the subject line. Additionally, your last name, homework number, and problem number shall all be included as part of your MATLAB file names (e.g., 'Mitrani_HW7PR2.m', 'Mitrani_HW7PR2_input.dat').

Midterms: Exams (2 midterms) contribute to 40% of your final grade. These exams will be written in order to test your understanding of the topics covered in class, homework, and quizzes. I encourage you to ask lots of questions in class and through the Discussion section of Blackboard to help prepare you for examinations. Students who are unable to take a scheduled exam (with a documented excuse) will schedule an alternate time to take the exam.

Project: The final project contributes to 40% of your final grade. Your final project will focus on contemporary seismic design issues. Fifty points of the project will be devoted to the final project report and fifty points will be devoted to the development of the project concept, PowerPoint slides, and the delivery of your in-class presentation describing the project. You can work with a partner on this project, but this is optional.

Disabilities: Any student with a disability who may need accommodations in this class must obtain an accommodation letter from Student Disability Services, 385 Garland, (410) 516-4720, studentdisabilityservices@jhu.edu

Ethics: The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. All violations of academic ethics will be prosecuted. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. For further information, please see the guide on "Academic Ethics for Undergraduates" and the Ethics Board Website (http://ethics.jhu.edu).

Schedule:	Date	Topic	Reading	HW
Single-Degree of Freedom Systems (SDOF)	25 Jan	**NO CLASS: Snow Day**		
	27 Jan	**NO CLASS: Snow Day**		
	01Feb	Lecture 1: Intro & Equations of Motion	Ch. 1	
	03 Feb	Lecture 2: Equations of Motion	Ch. 1	
	08 Feb	Lecture 3: Free Vibration	Ch. 2	
	10 Feb	Lecture 4: Response to Harmonic Excitation	Ch. 3A	HW 1 due
	15 Feb	Lecture 5: Response to Harmonic Excitation	Ch. 3B	
	17 Feb	Lecture 6: Response to Arbitrary and Step Excitations	Ch. 4A, B	HW 2 due
	22 Feb	Lecture 7: Response to Ramp & Pulse Excitations	Ch. 4C	
	24 Feb	Lecture 8: Numerical Methods	Ch. 5	HW 3 due
	29 Feb	Lecture 9: EQ Engineering (Linear Systems)	Ch. 6	
	02 Mar	Lecture 10: EQ Engineering (Linear Systems)	Ch. 6	HW 4 due
	07 Mar	Lecture 11: Final Project Overview Exam Review		
	09 Mar	**Exam 1**		
	14-18 Mar	**SPRING BREAK – NO CLASS**		
Multi-Degree of Freedom Systems (MDOF)	21 Mar	Lecture 14: Guest Lecture on OpenSEES		
	23 Mar	Lecture 15: EQ Engineering (Nonlinear Systems)	Ch. 7	HW 5 due
	28 Mar	Lecture 16: Equation of Motion for MDOF System	Ch. 9	
	30 Mar	Lecture 17: Natural Vibration; Free Vibration Response	Ch. 10A, B	HW 6 due
	04 Apr	Lecture 18: Damping	Ch. 11A	
	06 Apr	Lecture 19: Modal Analysis	Ch. 12A,B	HW 7 due
	11 Apr	Lecture 20: Modal Analysis	Ch. 12B	
	13 Apr	Lecture 21: Earthquake Analysis	Ch. 13A, B	HW 8 due
	18 Apr	Lecture 21: Earthquake Analysis; Exam Review	Ch. 13B	
	20 Apr	**Exam 2**		
	25 Apr	Lecture 23: EQ Design & Building Codes	Ch. 21	
	27 Apr	Lecture 24: Guest Lecture on EQ Design		
	07 May	**Final Project Presentations (2-5pm)**		