CE 8060 – STRUCTURAL DYNAMICS

FALL 2014 (Section 001)
215 Lowry Hall, TR – 9:30 – 10:45 A.M.
Professor: Dr. Sez Atamturktur *(Dr. Atam)*, sez@clemson.edu, 656-3003
Office Hours: By appointment

1. COURSE OBJECTIVES:

In this class, you will gain an understanding of the following topics:

- Dynamic equilibrium of single-degree of freedom systems
  - Free, forced harmonic and transient vibration responses
  - Undamped and damped vibration response
  - Approximate and numerical methods for dynamic analysis
  - Dynamic analysis in time and frequency domain
- Dynamic equilibrium of multi-degree of freedom systems
  - Formulation of mass and stiffness matrices
  - Lumped and distributed mass systems
  - Free vibration responses of undamped and damped systems
  - Generalized Eigenvalue problem and model superposition
  - Experimental Modal Analysis *(if time permits)*

2. COURSE ADMINISTRATION:

Administration: This course will be managed on ***MyClemson***, and is accessible to enrolled students at https://bb.clemson.edu/. Students are required to make use of this site, and frequently review it for updates.

Prerequisites: This course will assume (and require) your previous exposure to matrices and vectors, linear algebra and differential equations. C or better in CE 4010/6010 or Instructor Approval. A preliminary knowledge of MATLAB® programming is required.

Textbook: There will be no specific textbook assigned for this course for students to purchase. Reading material will be assigned and distributed on BB under the fair-use guidelines from various books. The following books are suggested as additional references if needed:

1. Fundamentals of Structural Dynamics by Roy R. Craig, Andrew J. Kurdila · Wiley · Hardback · 728 pages · ISBN 0471430447
2. Dynamics of Structures: Second Edition by J. Humar · Taylor & Francis · Paperback · 967 pages · ISBN 9058092461

Computer Software: MATLAB® will be used regularly to solve systems of linear equations and manipulating matrices to aid homework assignments. As a student of Clemson University, you have free access to MATLAB®.

3. COURSE GRADING and EXPECTATIONS:

Attendance: Students are responsible for all information administered in lecture sessions including announcements and potential schedule changes. If the instructor does not arrive within the first 15 minutes of the class, students may leave.

Grading: Homework & Quiz 50%, literature Review Paper 30%, Research Paper 20%. These weights are approximate; the right to change them later is reserved.

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Homework: All homework assignments (except the first homework) are to be completed and submitted by randomly selected groups of two students. The groups will be rotated for every assignment. Homework along with the group listing will be posted once (or twice) a week on BB. Partnering students must work together on homework and turn in homework that reflects their complete, *combined* understanding of the material. Any computer program developed for homework assignments must not be duplicates of other student groups' programs. This standard will be enforced by randomly asking groups to turn in their computer programs written for the homework problems or to explain their solutions to the professor. Students should expect 10-15 homework assignments during the semester. Homework assignments will not be accepted outside of the class period. No late homework will be accepted.

Quiz: Pop-quizzes will be regularly held during class periods. Students should expect 10-15 quizzes during the semester. Students are responsible for attending classes to participate in quizzes. Any quizzes missed due to absence will receive a zero grade.

Literature Review Paper: Students are asked to form groups of two for the Literature Review Paper. The groups for the Literature Review Paper, once assigned, will remain permanent until the completion of the assignment. Students who do not have a group by the end of the second class period will be randomly assigned in a group by Dr. Atam. The students can select a topic from the following list on a first-come first-serve basis (selected topic number will be the group number):

1. **Code and Solution Verification:** This topic is concerned with the role of numerical uncertainties and error in the calculation of dynamic behavior of systems
2. **Experimental Planning:** This topic is concerned with the best practices for designing, and executing dynamic testing.
3. **Feature Extraction:** This topic is concerned with the reduction of high-dimensional dynamic test data into meaningful low dimensional features that indicate the dynamic behavior of the system.
4. **Design of Experiments / Sampling:** This topic is concerned with the design of computer experiments to evaluate an ensemble of model predictions which allow trends in the data to be analyzed.
5. **Sensitivity Analysis / Effect Screening:** This topic is concerned with the identification and ranking of input parameters that are the most influential on the dynamic response of interest.
6. **Meta-modelling:** This topic is concerned with the development of mathematical approximations in lieu of physics-based models of structural dynamics.
7. **Uncertainty Assessment and Propagation:** This topic is concerned with the role of uncertainties in evaluating the dynamic behavior of structural systems.
8. **Validation Metrics:** This topic is concerned with the means in which numerical model predictions and experimental observations of dynamic response can be compared with each other.

9. **Test-analysis Correlation:** This topic is concerned with the comparison of numerical model predictions against experimental observations.
10. **Finite Element Model Updating:** This topic is concerned with the updating of finite element model parameters against experimentally measured dynamic parameters.
11. **Model Calibration and Revision:** This topic is concerned with the calibration of finite element model parameters against experimentally measured dynamic parameters.
12. **Predictive Maturity:** This topic is concerned with the predictive capabilities of numerical models to predict structural dynamics.
13. **Modelling and Simulation based Decision Making:** This topic is concerned with the aspects of decision-making under uncertainty regarding structural dynamics.

Students are asked to submit a draft literature review report of no more than five pages (due on Sep 25, 2014), a final literature review report (due on Oct 16, 2014) of no more than eight pages and give a presentation (scheduled on Oct 21-23, 2014). All page numbers are given excluding the list of references. Students will be given advice and mentoring in preparation of the report as much as needed. Students are encouraged to set up appointments with Dr. Atam.

Research Paper: Students are asked to form groups of three for the Research Paper. Students who do not have a group by Oct 23, 2014 will be randomly assigned into a group by Dr. Atam. Students will be asked to test a scaled laboratory specimen, mathematically model its behavior, and compare the results. Further guidance will be provided regarding the format of the research project throughout the semester.

4. UNIVERSITY STATEMENTS:

Clemson University's Academic Integrity statement can be found at:
http://www.clemson.edu/academics/integrity/

Clemson University's Disability Act statement can be found at:
http://www.clemson.edu/administration/student-affairs/student-handbook/universitypolicies/american-disabilities.html

Clemson University's Sexual Harassment statement can be found at:
http://www.clemson.edu/administration/student-affairs/student-handbook/universitypolicies/harassment.html

5. TENTATIVE CLASS SCHEDULE:

Date		Title
		Single Degree of Freedom Systems
Aug	21	L1 - An Overview of Structural Dynamics
	26	L2 - Formulation of SDOF System Equations
	28	L3 - Free Vibration of Undamped SDOF Systems
Sep	2	L4 - Free Vibration of Damped SDOF Systems
	4	L5 - Free Vibration of Damped SDOF Systems (Cont.)
	9	L6 - Forced Harmonic Vibration of Undamped SDOF Systems
	11	L7 - Forced Harmonic Vibration of Damped SDOF Systems
	16	L8 - Forced Harmonic Vibration of Damped SDOF Systems (Cont.)
	18	L10 - Base Excitation of SDOF Systems
	23	L11 - Base Isolation of SDOF Systems
	25	L12 - Transient Vibration of SDOF systems
	26	*Literature Review Report Draft Due (midnight)*
		Time and Frequency Domain Analysis Methods
	30	L13 - Introduction to Numerical Integration (Time domain)
Oct	2	L14 - Newmark's Numerical Integration Method (Time domain)
	7	L15 - Errors in and Stability of Numerical Integration (Time domain)
	9	L16 - Transformation Methods (Frequency domain)
	14	L17 - Fourier series representation of Periodic Loads (Frequency domain)
	16	L18 - Frequency Response Function (Frequency domain)
	16	*Literature Review Final Report Due (midnight)*
	21	L19 - Literature Review Paper Presentation
	23	L20 - Literature Review Paper Presentation
	28	L21 - Literature Review Paper Presentation
		Multi-Degree of Freedom Systems
	30	L22 - Formulation of MDOF System Equations
Nov	4	*Fall Break*
	6	L23 - Lumped and Distributed Mass MDOF Systems
	11	L24 - Formulation of Mass and Stiffness Matrices
	13	L25 - Static Condensation Techniques
	18	L26 - Generalized Eigenvalue Problem, Frequencies and Mode Shapes
	20	L27 - Modal Superposition Analysis of Free Response of MDOF Systems
	25	L27 - Research Paper Presentation
Dec	2	L27 - Research Paper Presentation
	4	L30 - Research Paper Presentation
	10	*Research Report Due (10:30 am)*

The right to change this schedule is reserved.