CE 893– STRUCTURAL HEALTH MONITORING
(Section: 002)

SPRING 2011

MWF - Lowry 215, 11:15 A.M. – 12:05 P.M.

Professor: Dr. Sez Atamturktur

sez@clemson.edu – Lowry 200

Office Hours: by appointment

COURSE OBJECTIVES:

Objective 1: Structural Sustainability

Structural Health Monitoring (CE 893) examines the use of low-cost, long term monitoring systems to keep civil infrastructure under constant surveillance, ensuring structural integrity. Moreover, the tools and skills the students will learn in this class can be implemented to develop sustainable maintenance and rehabilitation schemes and programs.

Objective 2: Structural Resiliency

Structural Health Monitoring (CE 893) covers the concepts of rapid after disaster assessment of civil infrastructure. The tools and skills incorporated within the curriculum of this class provide quantitative means to assess the structural integrity loss a system undergoes after natural disasters and other hazardous events.

To achieve the aforementioned objectives, this course covers a wide spectrum of methods that can be used to monitor the structural health of civil infrastructure.

- *Provide an introduction and brief history of SHM.*
- *Provide a systematic approach to SHM process.*
- *Overview nondestructive test techniques relevant to SHM.*
- *Review of Structural Dynamics.*
- *Provide hands-on experience with experimental modal analysis (input output modal analysis).*
- *Provide hands-on experience with operational modal analysis (output-only modal analysis).*
- *Overview Signal Processing basics.*
- *Overview existing passive and active sensing technology.*
- *Introduce feature extraction and provide a comprehensive list of comparative features.*
- *Overview data normalization and assimilation techniques.*
- *Introduce the concept of damage detection.*
- *Introduce a multi-disciplinary, data-driven approach to develop SHM solutions.*
- *Introduce students to the concepts of statistical pattern recognition and demonstrate the application of this technology to SHM.*
- *Overview a multi-disciplinary, model-based approach to develop SHM solutions.*
- *Show applications and discuss current state of the technology.*
- *Introduce students to the concepts of model calibration and demonstrate the application of this technology to SHM.*
- *Show applications and discuss current state of the technology.*

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COURSE ADMINISTRATION:

Administration: This course will be managed on ***MyCLEmson***, and is accessible to enrolled students at https://bb.clemson.edu/. Please make use of this site, and consistently check it for updates.

Prerequisites: Basic understanding of finite element analysis; structural dynamics, probability and statistics; signal processing; linear algebra; MATLAB™; and functional analysis.

Required Text: There is no required text for this course. Students will be provided with reading material through **MyCLEmson**.

Additional Office Hours: When necessary, additional meetings may be arranged with the primary instructor via email.

The Honor Code: Each student must comply with the Honor Code as approved by The College of Engineering of Clemson University.

All major course announcements, including date changes, will be given in lecture sessions. Students are responsible for all information administered in lecture sessions. Therefore, attendance to lecture sessions is mandatory. However, if the instructor does not arrive within the first 15 minutes of the class, students may leave.

ACADEMIC INTEGRITY:

As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a "high seminary of learning." Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form.

When, in the opinion of a faculty member, there is evidence that a student has committed an act of academic dishonesty, the faculty member shall make a formal written charge of academic dishonesty, including a description of the misconduct, to the Associate Dean for Curriculum in the Office of Undergraduate Studies. At the same time, the faculty member may, but is not required to, inform each involved student privately of the nature of the alleged charge.

DISABILITY ACCESS STATEMENT:

It is University policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities. Students are encouraged to contact Student Disability Services to discuss their individual needs for accommodation.

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COURSE GRADING:

Written term project report	(12 assignments)	60%
Project oral presentation	(2 – 3 presentations)	20 %
Assignments	(4 – 5 assignments)	20%

Because the 14 assignments of the written term project will be cumulative, the term project will be graded in a fully Bayesian context. Every new term project assignment can have a ±5% impact on your overall term project grade. In the beginning of the semester, everybody will start with a full 60% term project credit. Every presentation can have a ±20% impact on your overall presentation grade. In the beginning of the semester, everybody will start with a full 20% oral presentation credit.

This course's grades may be curved or adjusted to shift students' grades positively, but not negatively.

TENTATIVE COURSE OUTLINE:

1. Course Introduction, SHM introduction
2. Brief History of SHM, Operational Evaluation
3. Case Studies Relevant to Structural Sustainability
4. Case Studies Relevant to Structural Resiliency
5. SHM Procedure
6. Brief Overview of Structural Dynamics
7. Operational evaluation of the structure
8. Experimental Modal Analysis (input-output modal analysis)
9. Operational Modal Analysis (output only modal analysis)
10. Data acquisition
    - Obtaining useful measurements
    - Excitation
    - Sensing
    - Data transmission
    - The coherence function
11. Signal Processing Basics
12. Feature extraction
13. Data Normalization
14. Rapid Damage Detection (Resiliency) & Long Term Periodic Monitoring (Sustainability)
    - Data-based: Statistical model development
    - Model-based: Finite Element model updating
15. Student Class Projects (a discussion on how they relate to sustainability and resiliency)

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