Department of Building, Civil and Environmental Engineering

CIVI 6061: Structural Health Monitoring (SHM), Winter 2017

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Lectures: Wednesday 17:45-20:15
Class room: H 431
Office hour: Monday 11:00 AM – 12:00 PM, Wednesday & Thursday 4:30 PM - 5:30 PM

Overview:
Structural health monitoring (SHM) is an emerging area in Civil Engineering that will be widely adopted in major projects. The main purpose of SHM is to study the in-situ or the field behaviour of a structure through appropriate instrumentation and tests in order to facilitate effective maintenance that helps keeping the structure in good condition and extending its service life beyond the design life. The course will familiarize the students with the concepts and techniques related to SHM in order to better prepare them to meet the challenges in this area and take a leadership role.

The main topics covered are:

- The current state of modern infrastructure
- What is structural health monitoring and why is it needed?
- Introduction to structural rehabilitation and innovative materials and techniques for it.
- Components of civil infrastructure including smart and innovative structures.
- Structural health monitoring: principles, techniques, implementation, interdisciplinary approach, advantages and challenges.
- Structural design vs. Maintenance: life expectancy of a structure and life-cycle costing
- SHM systems: Component and system design, sensors and instrumentation, data acquisition, data management, interpretation of SHM data, assessment of structural condition, and decision making.
- Damage detection methods: local and global, analytical and experimental, non-destructive evaluation, and vibration-based damage identification.
- Cost-benefit analysis of SHM

It should be noted that the course is based on an emerging topic in Civil Engineering with interdisceplinary flavour. Many of the topics are new and **no text book** is available for the course. Although main concepts will be discussed in the class, students are expected to do **significant amount of "self study"** and discuss the issues in the class. There will be a number of **assignments** and **a project**. The students are expected to spend significant amount of time each week on reviewing course materials, studying the assigned readings, and working on the project. *Prior background in Structural Analysis and Design, Structural Dynamics, and Finite Element Method would be very useful.*

Evaluation and Grading:
Course grades will be determined as follws:

Assignments (3)	= 15%
Project	= 35% (preliminary report 5%, presentation 10% and final report 20%)
Mid-term test	= 10% (closed book)
Final exam	= 40% (closed book)

The project will be in individual format for MASc/PhD students and in group format for MEng students (up to 3 MEng students per group) which will focus on various elements of SHM and they will provide an opportunity for the students to explore the chosen topics in more detail. The project reports (prelim and final) must be generated on computers and printed on laser printers. Hand written papers will not be accepted. The interim report and the assignments must be turned in the class on the due date. Late submission with penalty will be accepted only with the prior approval of the instructor. You are required to attach the signed ***form of originality*** to every report.

The preliminary project report will contain the introduction to the project topic, preliminary literature survey, detailed objective, methodology and expected results. The report should be limited to 5 pages. Each group has to present the project ideas in the class using power point presentation. The approximate duration of the presentation would be 10 minutes. The final report will be more elaborate and general guidelines on the final report will be provided in the class.

For the final project report, students must submit online which must contain the electronic version of the report and all relevant data and resource files related to the project.

Cheating, Plagiarism and Computer Use:
Everyone is expected to do individual work on tests, assignments, and project. Any occurence of chating or plagiarism will be dealt with in accordance with the university policy. Abuse of computing facility will not be tolerated and your access will be immediately cancelled. You are expected to conform to all license agreements for any software you are given access to.

References:
There is no text book for the courese. However, course notes and resourses will be posted on the course website. There is also a huge volume of information available on the internet.

Tentative schedule

Week	Date	Topic	Deliverable
1	Jan 11	Introduction to SHM, structural rehabilition and Infrastructure Management	
2	Jan 18	Civil Infrastructure. Need for SHM. Basic principles and techniques.	
3	Jan 25	SHM: Basic principles and techniques Components of SHM systems	Assignment 1 Project Proposal
4	Feb 1	Components of SHM systems Structural Design vs. Maitenance.	
5	Feb 8	Sensors and Instrumentation, Measurement – error and accuracy	
6	Feb 15	Data Management, Communication and Storage Continuous and periodic monitoring	Assignment 2
7	Feb 22	*Mid-term break*	
8	Mar 1	Interpretation of SHM data	Interim Report **Mid-term test**
9	Mar 8	Structural Condition Assessment and decision making	*Student presentation*
10	Mar 15	Damage detection methods. Vibration-based damage identification – Analytical Methods. Structural Dynamics	Assignment 3 *Student presentation*
11	Mar 22	Cost-benefit analysis of SHM. Life-cycle Cost.	*Student presentation*
12	Mar 29	Data-driven models, Statistical and Neural Networks methods	*Student presentation*
13	Apr 5	Local and global methods. Non-destructive evaluation (NDE)	
14	Apr 12	Case studies and new advances	

The due date for the final report and the date of test/exam will be announced later in the class.