

**CEE 4803 Spring 2013**  
**Introduction to Non-Destructive Testing and Forensic Evaluation**  
**in Engineering Materials and Structures**

| <u>Instructors</u>    | <u>Office Hours</u> | <u>Office</u> | <u>Email</u>   |
|-----------------------|---------------------|---------------|--|
| Prof. Kimberly Kurtis | F 10 am – 12 pm     | 42 CoC        | <a href="mailto:kkurtis@ce.gatech.edu">kkurtis@ce.gatech.edu</a>     |
| Prof. David Scott     | Tu/Th 930-1030 am   | 211 SL        | <a href="mailto:dscott@gatech.edu">dscott@gatech.edu</a>             |
| Prof. Yang Wang       | Tu/Th 4-5 pm        | 44 CoC        | <a href="mailto:yang.wang@ce.gatech.edu">yang.wang@ce.gatech.edu</a> |

**Class Meeting:** MW 12-1:30 pm, Instructional Center 207

**Prerequisite Knowledge:** Differential equations (MATH 2403), mechanics of deformable bodies (COE 3001), materials science (MSE 2001-Principles and Applications of Engineering Materials *or* CEE 3020-Materials of Construction), One design elective from among the following: (CEE 4510, CEE 4520, CEE 4530).

**Required Materials:** “Nondestructive Test Methods for Evaluation of Concrete in Structures,” ACI 228.2R-98, American Concrete Institute

“Guide for Evaluation of Concrete Structures Before Rehabilitation,” ACI 364.1 R-07, American Concrete Institute

Diagnosis of Deterioration in Concrete Structures,” Concrete Society Technical Report No. 54, The Concrete Society, 2000, (ISBN 0-946691-81-8) – *will be posted to T-Square*

“Guide for Making a Condition Survey of Concrete in Service,” ACI 201.1R-97, American Concrete Institute – *will be posted to T-Square*

Handbook of Analytical Techniques in Concrete Science and Technology, VS Ramachandran and JJ Beaudoin (Eds), William Andrews Pub/Noyes, 2001

*Available free online:*

[http://www.knovel.com.prx.library.gatech.edu/web/portal/browse/display?\\_EX\\_T\\_KNOVEL\\_DISPLAY\\_bookid=265](http://www.knovel.com.prx.library.gatech.edu/web/portal/browse/display?_EX_T_KNOVEL_DISPLAY_bookid=265)

D . Huston, Structural Sensing, Health Monitoring, and Performance Evaluation, Taylor & Francis, 2010 (ISBN 978-0-7503-0919-6).

*Available free online:*

<http://www.crcnetbase.com.prx.library.gatech.edu/isbn/9781420012354>.

R. Ratay, Forensic Structural Engineering Handbook, 2<sup>nd</sup> Edition, McGraw-Hill, 2009 (ISBN 978-0071498845).

*Available free online:*

<http://site.ebrary.com.prx.library.gatech.edu/lib/gatech/docDetail.action?docID=10355318>.

*Other books/articles as assigned*

**Course Objectives:**

At the conclusion of this course, students will:

1. Understand the role of site inspection, condition assessment, structural health monitoring, and post-failure analysis in the ethical practice of forensic engineering.
2. Become familiar with techniques for imaging and sample analysis of concrete, as well as an understanding of the circumstances when each may be used appropriately.
3. Become familiar with techniques for destructive and non-destructive testing, as well as an understanding of the circumstances when each may be used appropriately.
4. Be able to use stress wave, magnetic, electrical, and radar methods for identification of defects in structural components.
5. Become familiar with structural health monitoring techniques, such as dynamic modal characterization and finite element model updating, as well as their applications in the field.
6. Be able to apply their knowledge of the principles and techniques mentioned above to understand the cause(s) of a modern civil engineering failure, demonstrated in a case study.

**Grading Policy:**

|                  |      |
|------------------|------|
| Homework         | 15 % |
| Midterm          | 30 % |
| Case Study       | 20 % |
| Peer Evaluations | 5 %  |
| Final            | 30 % |

**Academic Policy:**

This course will be conducted under the guidelines of the Georgia Tech Academic Honor Code - <http://honor.gatech.edu>

## COURSE OUTLINE

| Lead                               | Description  | Reading   | Lecture   |
|------------------------------------|--|---|-----------|
| ALL                                | Introduction <ul style="list-style-type: none"> <li>• Course Expectations</li> <li>• Text and Reference Materials</li> <li>• Student Evaluation Metrics</li> </ul>   |   | 1         |
| ALL                                | Forensic Engineering – Three Aspects <ul style="list-style-type: none"> <li>• Structural Health Monitoring</li> <li>• Evaluation of Deterioration in Service</li> <li>• Post-Failure Analysis</li> </ul>   |   | 2         |
| KK                                 | Ethics (HW 1)  | Lewis, Ch 4   | 3         |
| DS                                 | Decision Criteria for Evaluation/Repair/Rehabilitation <ul style="list-style-type: none"> <li>• Service Life – Design versus Reality</li> <li>• Responsibilities of Involved Parties</li> <li>• Governmental / Legislative Interest/Oversight</li> <li>• Repair versus Replacement</li> </ul>  | Ratay, Ch 17  | 4         |
| DS                                 | Condition Assessment of Existing Structures <ul style="list-style-type: none"> <li>• Collecting pertinent documentation</li> <li>• Field investigation</li> <li>• Data collection methods (overview)</li> <li>• Laboratory testing protocols (overview)</li> <li>• Structural versus aesthetic considerations</li> <li>• Summary report / recommendations</li> </ul> | ACI 364.1<br>CSTR 54, Ch 1-2                                    | 5         |
| KK                                 | NDT versus Destructive Testing – General Differences <ul style="list-style-type: none"> <li>• Field / Laboratory</li> </ul>  | Ramachandran,<br>Ch. 17   | 6         |
| KK                                 | Destructive methods <ul style="list-style-type: none"> <li>• mechanical and physical properties</li> <li>• durability testing</li> </ul>   | Ramachandran,<br>Ch. 17   | 6-7       |
| KK                                 | Characterization methods <ul style="list-style-type: none"> <li>• Imaging and microscopy</li> <li>• Analytical methods</li> </ul>  | Ramachandran,<br>Chs. 2-4, 7,8, and<br>20.4-20.7                | 8-10      |
| DS/YW                              | Visual inspection techniques <ul style="list-style-type: none"> <li>• general methodology</li> <li>• supplemental tools</li> <li>• thermography</li> </ul>   | ACI 201.1<br>CSTR 54<br>ACI 228.2, Ch 2.7                       | 11        |
| <b>MIDTERM – FEBRUARY 18, 2013</b> |  |   | <b>12</b> |
| DS/KK                              | Stress-wave methods (HW2) <ul style="list-style-type: none"> <li>• sounding/surface percussion</li> <li>• impact/echo</li> <li>• ultrasonic pulse velocity/echo</li> <li>• sonic echo</li> <li>• spectral analysis of surface waves</li> <li>• impedance logging</li> </ul>  | ACI 228.2, Ch 2.2<br>Carino (2013)                              | 13-16     |
| KK/DS                              | Magnetic/electrical methods <ul style="list-style-type: none"> <li>• covermeters</li> <li>• half-cell potential</li> <li>• polarization</li> </ul>   | ACI 228.2, Ch 2.5,<br>Ramachandran,<br>Ch. 12<br>BRE Digest 434 | 17-18     |
| YW                                 | Radar  |   | 19-20     |

| <b>Lead</b> | <b>Description</b>   | <b>Reading</b>   | <b>Lecture</b> |
|-------------|--|--|----------------|
| YW          | Structural health monitoring approaches (HW3) <ul style="list-style-type: none"> <li>• Sensors, data acquisition, and signal processing</li> <li>• Fiber-optic sensors</li> <li>• Wireless smart sensors</li> <li>• Vibration-based structural health monitoring (SHM)</li> <li>• Bridge SHM applications</li> </ul> | Brownjohn 2006;<br>Huston Ch 2 & 4;<br>Lynch & Loh<br>2006;<br>Ko & Ni 2005. | 21-24          |
| ALL         | Forensics Case Studies – Applications of NDT with Analytical and Destructive Methods   |  | 25-27          |
| ALL         | Student Case Study Presentations   |  | 28-29          |

**Disclaimer:** When appropriate or necessary, the instructors reserve the right to adjust, amend, or otherwise modify the information presented on this syllabus at any time.