**CEE 6538**

**Introduction to Non-Destructive Testing and Forensic Evaluation in Structures**

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| **Instructors** | **Office Hours** | **Office** | **Email** |
| Prof. David Scott | Tu / Th 10-11 am | Mason 5142A | [dscott@gatech.edu](mailto:dscott@gatech.edu) |
| Prof. Yang Wang | M / W 3 – 4 pm | Mason 4160 | [yang.wang@ce.gatech.edu](mailto:yang.wang@ce.gatech.edu) |
| Prof. Kimberly Kurtis | M / W 9-10 am | Mason 4154 | [kkurtis@ce.gatech.edu](mailto:kkurtis@ce.gatech.edu) |

**Class Meeting:** Tu/Th 3:05 - 4:25 pm, Mason 2117

# Prerequisite Knowledge:

Undergraduate mechanics of deformable bodies, materials science, and at least one senior level civil engineering design elective

# Required Materials:

“Report on Nondestructive Test Methods for Evaluation of Concrete in Structures,” ACI 228.2R-13, American Concrete Institute, ISBN: 9780870318207

*One procedure to procure the above document is to join ACI as a student member (it is free!), and then buy the document at the member price.* [*http://www.concrete.org/Membership/StudentMembership.aspx*](http://www.concrete.org/Membership/StudentMembership.aspx)

“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 Conducting a Visual Inspection of Concrete in Service,” ACI 201.1R-08, American Concrete Institute – *will be posted to T-Square*

“Guide for Evaluation of Concrete Structures Before Rehabilitation,” ACI 364.1 R-07, 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?\_EXT\_KNOVEL\_DISPLAY\_bookid=265*](http://www.knovel.com.prx.library.gatech.edu/web/portal/browse/display?_EXT_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.*](http://www.crcnetbase.com.prx.library.gatech.edu/isbn/9781420012354)

R. Ratay, Forensic Structural Engineering Handbook, 2nd Edition, McGraw-Hill, 2009 (ISBN 978- 0071498845). *Available free online:* [*http://site.ebrary.com.prx.library.gatech.edu/lib/gatech/docDetail.action?docID=10355318.*](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:

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

**Academic Policies:** This course will be conducted under the guidelines of the Georgia Tech Academic Honor Code - [http://honor.gatech.edu](http://honor.gatech.edu/)

Georgia Tech has policies regarding disability accommodation, which are administered through The Office of Disability Services: [http://disabilityservices.gatech.edu/.](http://disabilityservices.gatech.edu/) For students with disabilities, please contact this Office to request classroom accommodations.

# COURSE OUTLINE

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| **Lead** | **Description** | **Reading** | **Lecture** |
| ALL | Introduction   * Course Expectations * Text and Reference Materials * Student Evaluation Metrics |  | 1 |
| ALL | Forensic Engineering – Three Aspects   * Structural Health Monitoring * Evaluation of Deterioration in Service * Post-Failure Analysis |  | 2 |
| KK | Ethics | Lewis, Ch 4 | 3 |
| DS | Decision Criteria for Evaluation/Repair/Rehabilitation   * Service Life – Design versus Reality * Repair versus Replacement Condition Assessment of Existing Structures * Collecting Pertinent Documentation * Field Investigation * Summary Report / Recommendations | Ratay, Ch 17  ACI 364.1  CSTR 54, Ch 1-2 | 4 |
| KK | NDT versus Destructive Testing – General Differences   * Field / Laboratory | Ramachandran, Ch. 17 | 5 |
| KK | Destructive Methods   * Mechanical and Physical Properties * Durability Testing | Ramachandran, Ch. 17 | 5-6 |
| KK | Imaging | Ramachandran, Chs. 2, 7 | 7 |
| YW | Infrared Thermography | ACI 228.2, Ch 3.7 | 8 |
| KK | Analysis Methods | Ramachandran, Chs. 2-4, 8 | 9-10 |
| DS | Stress Waves   * Sounding/Surface Percussion * Resonant Frequency * Ultrasonic / Sonic Pulse Velocity * Impact Echo * Impulse Response | ACI 228.2, Ch 3.2  Carino (2013) | 11-13 |
| DS/YW | Lab Sessions   * Infrared Thermography * Stress Waves |  | 14-15 |
| **MIDTERM** | | | **16** |
| DS | Magnetic/electrical methods   * Covermeters * Half-cell Potential * Polarization | ACI 228.2, Ch 3.5,  Ramachandran, Ch. 12  BRE Digest 434 | 17-18 |
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| **Lead** | **Description** | **Reading** | **Lecture** |
| YW | Radar | Ch 3.3.7, Huston | 19 |
| DS/YW | Lab Sessions   * Magnetic and Electrical Methods * Radar |  | 20-21 |
| YW | Sensors for Structures | Ch 2, Huston | 22 |
| YW | Fiber Optic Sensors | Ch 3.2.6, Huston | 23 |
| YW | DAQ and wireless sensing | Ch 4.1 & 4.2,  Huston | 24 |
| YW | Modal Testing | Brownjohn 2006; Lynch & Loh 2006; Ko & Ni  2005. | 25-26 |
| ALL | Forensics Case Studies – Applications of NDT with Analytical and Destructive Methods |  | 27-28 |
| ALL | Student Case Study Presentations |  | 29-30 |
| **FINAL EXAM** | | | |

**Disclaimer:** When appropriate or necessary, the instructors reserve the right to adjust, amend, or otherwise modify the information presented on this syllab