



## **CE 597- Non-destructive Testing & Sensing for Civil Infrastructures**

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### **Course Description**

This course will introduce students to the field of non-destructive testing (NDT) and sensing techniques for understanding materials and structural integrity in civil infrastructure system. A special emphasis will be placed on NDT techniques for steel and concrete structures. The knowledge will be discussed including: fundamental failure mechanism of civil materials and structure integrity, basic principles of data acquisition and signal processing, testing procedures of commonly used NDT methods for steel and concrete structures and advanced infrastructure sensing techniques, such as fiber optics, embedded sensor networks etc. Various case studies will be discussed to help students understand and apply the knowledge to field inspection or monitoring of civil materials and structures. **Hands-on lab will be provided to students enrolled in the course including common NDT methods and associated data processing.**

Upon completion, students are expected to understand the fundamental theory and principles of major NDT techniques and their associated equipment and applications. Students should be able to identify appropriate NDT technique for various civil engineering materials and structure testing.

Five major course modules include:

- Fundamentals of Civil Materials & Structure Integrity
- Basic Principles of Non-destructive Testing Methods
- Non-destructive Testing Methods for Steel Structures
- Non-destructive Testing Methods for Concrete Structures
- Civil Infrastructure Sensing Techniques

### **Prerequisites:**

Engineering Mechanics, Engineering Materials or by the instructor's consent

### **Learning Objectives**

- Be familiar with terminology and basic concepts of materials and structure failure mode, and failure mechanisms
- Understand basic principles of various NDT techniques including stress wave, magnetic, electrical, radar and fiber optics-based methods
- Be familiar with typical data acquisition and signal processing involved in NDT methods
- Be familiar with equipment and testing procedures of common NDT methods used for civil infrastructure materials and structures
- Understand working mechanisms of various infrastructure sensing and monitoring technologies, their applications and limitations



# CE 597: Non-destructive Testing & Sensing for Civil Infrastructures

## School of Civil Engineering, Purdue University

- Be able to identify and apply appropriate NDT methods for materials and structural health monitoring and sensing
- Be able to perform hands on testing and make decisions after data processing.
- Be able to professionally report the NDT testing results in both oral and written format

### Textbook and References:

No textbook is required, but reference books and resources are suggested as below:

- Alten F. Grandt Jr, Fundamentals of Structural Integrity, Damage Tolerant Design and Nondestructive Evaluation, Wiley Publishing, 2004
- D. Huston, Structure Sensing, Health Monitoring and Performance Evaluation, Tylor & Francis, 2010.
- R. Ratay, Forensic Structural Engineering Handbook, 2<sup>nd</sup> Edition, McGraw-Hill, 2009
- Non-destructive Testing Methods for Evaluation of Concrete in Structures, ACI 228.2R-98. American Concrete Institute.
- Guide for Evaluation of Concrete Structure 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.
- Martinček, Dynamics of Pavement Structures. CRC Press, 1994

### Course Structures:

Lectures; in-class exercise; individual presentations (case study) and final project/presentations

### Grading Policy:

Assessment Type	Description	% Of Final Grade
Homework	Throughout the semester	30
Quizzes	Quizzes will be performed weekly to test the student's understanding of the class content.	20
Lab reports	Hands on lab for various type of NDT methods	30
Final presentation & term paper	Project related to course topic will be required.	20



**Tentative Course Schedules (Fall 2020)**

<b>Week</b>	<b>Course Topics</b>	<b>Course Modules</b>
1	L1: Introduction to course	Fundamentals & Principles of NDT
	L2: Review of Materials & Structural Integrity	
2	L3: Elasticity	
	L4: Fracture mechanics	
3	L5: Materials and Structural Performance Evaluation	
	L6: Typical NDT Methods & Selection Criteria	
4	L7: Wave Propagation	
	L8: Wave-stress relations	
5	L9: Forensic structural engineering	
	L10: Lab activity 1 (Case study)	
6	L11: Piezoelectric Materials	Wave-based NDT
	L12: Piezoelectric transducer	
7	L13: Ultrasonic Method I	
	L14: Ultrasonic Method II	
8	L15: Acoustic Emission	
	L16: Lab activity (Ultrasonic & AE)	
9	L17: Resonant Frequency	
	L18: Electromechanical Methods I	
10	L19: Electromechanical Methods II	
	L20: Lab activity (EMI & RF)	
11	L21: Visual Inspection & Liquid Penetration	Electrical-based NDT and others
	L22: Eddy current	
12	L23: Radiography Principle	
	L24: Radiography Based Method	
13	L25: Distributed Fiber-Optics Sensing	
	L26: Laser for Infrastructure Sensing	
14	L27: Wireless Sensor Network	
	L28: Thanksgiving vacation	
15	L29: Term Paper Presentation	
	L30: Term Paper Presentation	

**Note:** the tentative course schedule is subject to change, which will be promptly communicated to the class during the semester.



## **General Policies and Rules**

### **Attendance and Homework Policy**

Students are required to attend every class section and actively participate in the class discussion. No late homework submission is accepted.

### **General Information on Academic Integrity**

**Academic integrity is expected of all students at all times.** Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, University Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972] Information on what constitutes academic integrity may be found in the Purdue's student guide for academic integrity (<http://www.purdue.edu/odos/aboutodos/academicintegrity.php> ).

### **Use of Copyrighted Materials**

Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.

Notes taken in class are, however, generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor. To obtain permission to sell or barter notes, the individual wishing to sell or barter the notes must be registered in the course or must be an approved visitor to the class. Course instructors may choose to grant or not grant such permission at their own discretion, and may require a review of the notes prior to their being sold or bartered. If they do grant such permission, they may revoke it at any time, if they so choose.

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Purdue University is committed to providing a safe and secure campus environment for members of the university community. Purdue strives to create an educational environment for students and a work environment for employees that promote educational and career goals. Violent Behavior impedes such goals. Therefore, Violent Behavior is prohibited in or on any University Facility or while participating in any university activity. See the following website for additional information: [http://www.purdue.edu/policies/pages/facilities\\_lands/i\\_2\\_3.shtml](http://www.purdue.edu/policies/pages/facilities_lands/i_2_3.shtml).

### **Students with Disabilities**



Purdue University is required to respond to the needs of the students with disabilities as outlined in both the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 through the provision of auxiliary aids and services that allow a student with a disability to fully access and participate in the programs, services, and activities at Purdue University. If you have a disability that requires special academic accommodation, please make an appointment to speak with me within the first three (3) weeks of the semester in order to discuss any adjustments. It is important that we talk about this at the beginning of the semester. It is the student's responsibility to notify the Disability Resource Center (<http://www.purdue.edu/drc>) of an impairment/condition that may require accommodations and/or classroom modifications.

### **Emergency Communication**

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website (Blackboard) or will be emailed to the course email list. If you have information this can be obtained by contacting the instructors via email. You are expected to read your @purdue.edu email on a frequent basis.

### **Nondiscrimination**

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life.

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