CEE **638**-102-**Non-Destructive Testing methods in Civil Engineering**
(3 credits)

Lectures Day and Time: Thursdays: 6:00pm – 8:50pm
Classroom Location: Kupfrian, KUPF 205
Instructor **Esmeralda Vataj, PhD**
Office Hours: Thursdays 12:00- 2:00PM
Office: 466 Tiernan Hall
E-Mail: ev96@njit.edu
(973) 642-4283
Webex room: https://njit.webex.com/meet/ev96

Recommended Texts & Reading
Nondestructive Evaluation – Theory, Techniques, and applications, ed. Peter J. Shull, Marcel Dekker, 2002, ISBN: 0-8247-8872-9.

Nondestructive Evaluation: a Tool in Design, Manufacturing, and Service, Don E. Bray & Roderic K. Stanley, CRC Press, 1997, ISBN: 0-8493-2655-9.

Introduction to Nondestructive Testing: a Training Guide, 2nd ed., Paul E. Mix, John Wiley & Sons, 2005, ISBN: 0-471-42029-8.

Handbook of Nondestructive Evaluation, Charles J. Hellier, McGraw-Hill, 2001, ISBN: 0-07- 028121-1.
Handbook on Nondestructive Testing of Concrete: Second Edition, V.M. Malhotra and N.J. Carino
http://www.ndt-ed.org

Course Description *(from NJIT's course catalog)*

Familiarizes the civil engineering student with nondestructive testing (NDT) techniques currently employed for evaluation and condition monitoring of civil structures and construction materials. Major emphasis in the application of NDT methodologies to steel, concrete, and timber as the construction material. Covers theories, principles, and testing methodologies associated with individual technologies from specific material point of view. Discusses advantages and limitations pertaining to the application of individual NDT technologies to construction materials.

Course Objectives (General)
By the end of this course, the student will be able to:

To define non-destructive testing and applications used in NDE;
Describe the basic principles and the method of application of the common NDE techniques;
Discuss the best applications, limitations and problems relating to the use of each method.
Describe, interpret, analyze and evaluate the defectology of metallic and nonmetallic materials;
Students will also learn specific NDE methods for civil engineering, such as GPR, PIT, and PDA, and for mechanical engineering, such as welds and composite materials inspection.

POLICIES & PROCEDURES

Academic Integrity: It is expected that NJIT's University Code on Academic Integrity will be followed in all matters related to this course. Refer to NJIT's Dean of Students website to become familiar with the Code on Academic Integrity and how to avoid Code violations.

https://www.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf

Communication: NJIT Canvas System, E-mail and Webex will be used for communications out of the class time. Lectures, reference materials, quizzes, grades are posted on Canvas, CEE 638. So, check there often.

Lectures/Class: It is expected that students will attend all lectures. Attendance will be taken at all classes and exams. More than 3 unexcused absences (in total) are excessive. If you have excusable absences contact the Dean of Students.
The students are expected to participate in the class discussions.

Handouts: Lecture handouts will be posted on Canvas course.

Projects: Projects will be assigned to encourage further reading, to extend the material presented in lectures, and to provide practice in arriving at engineering solutions to problems.
Completion of the projects is an essential part of the learning process. All assignments are to be turned in individually unless specified otherwise on the assignment. If you collaborate with a classmate (or two) be sure to state that collaboration and their names at the top of your assignment.

Quizzes: There will be quizzes during the semester to see the progress of the concepts learned during the lectures.

Exams: There will be a Midterm Exam held during class time and a Final Exam as scheduled by the University Registrar.

Calculation of Course Grade: A weighted average grade will be calculated as follows:

Project	15%
Quizzes	25%
Midterm Exam	27%
Final Exam	33%

The minimum requirements for final letter grades are as follows:

A = 90%, B+ = 85%, B = 80%, C+ = 75%, C = 70%, D = 60%, F < 60%
Note: Grades are not curved. It is theoretically possible for everyone in the class to get an A (or an F). Your performance depends only on how you do and how much you learn, not on how everyone else in the class does. It is therefore in your best interest to help your classmates, while acting within the bounds of the stated academic integrity policy (i.e., NJIT's Code of Academic Integrity).

Instructor Commitment: You can expect the Instructor to be courteous, punctual, organized, and prepared for lecture and other class activities; to answer questions clearly; to be available during office hours or to notify you beforehand if office hours are moved; to provide a suitable guest lecturer or pre-recorded lecture when they are traveling or unavailable; and to grade uniformly and consistently.

Students with Documented Disabilities: NJIT is committed to providing students with documented disabilities equal access to programs and activities. If you have, or believe that you may have, a physical, medical, psychological, or learning disability that may require accommodations, please contact the Coordinator of Student Disability Services located in the Center for Counseling and Psychological Services, in Campbell Hall, Room 205, (973) 596-3414. Further information on disability services related to the self-identification, documentation and accommodation processes can be found on the webpage at: (http://www.njit.edu/counseling/services/disabilities.php)

Course Outline:

1. Introduction to NDE (10%)
   - What is Nondestructive Evaluation?
   - Methods of NDE
   - Applications of NDE
   - Reliability of NDE

2. Visual Inspection (5%)
   - Introduction
   - Basic principles
   - Manual Vision Inspection
   - Automated or Machine Vision Inspection
   - Advantages and Limitations

3. Liquid Penetrant Testing (5%)
   - General Introduction
   - Penetrant Materials and Considerations
   - Basic Steps in Penetrant Testing
   - Common Equipment
   - Advantages and Limitations

4. Ultrasonic Testing (20%)
   - Applications
   - Basic Principles of sound generation
   - Pulse echo and through transmission testing
   - Inspection applications
   - Equipment
   - Data presentation
   - Advantages and Limitations

5. RADAR and microwaves (5%)
   - Introduction and physical basics
   - Principle of the measurement
   - Instrumentations and applications

6. Magnetic Particle (5%)
   - Magnetism and Ferromagnetic Materials
   - Introduction of Magnetic Particle Inspection
   - Basic Procedure and Important Considerations

- Examples of MPI Indications

7. Eddy Current (5%)
   - Electromagnetic induction
   - Generation of eddy currents
   - Inspection applications
   - Equipment utilized in eddy current inspection
   - Advantages and Limitations

8. Radiology (15%)
   - Electromagnetic Radiation
   - General Principles of Radiography
   - Sources of Radiation
   - Imaging Modalities
   - Computed Tomography (CT)
   - X-Ray Back Scattered
   - Radiation Safety
   - Advantages and Limitations

9. Thermography (5%)
   - Introduction and Background
   - Theory of Heat Diffusion
   - Techniques
   - Applications

10. Acoustic Emission Testing (5%)
    - Introduction and Background
    - Applications

11. NDE Application (10%)
    - Mechanical Engineering
    - Civil Engineering

12. Advanced Ultrasonic Testing Methods (10%)
    - Phased Array Ultrasonic Testing (PAUT)

CE 638 Class Schedule for Spring 2023

Week of	Lecture Topics
Week 1, Jan 18	Lecture 01: Introduction to NDE
Week 2, Jan 25	Lecture 02: Visual Inspection
Week 3, Feb 01	Lecture 03: Liquid Penetrant Testing
Week 4, Feb 08	Lecture 04: Magnetic Particle
Week 5, Feb 15	Lecture 05: Eddy Current
Week 6, Feb 22	Lecture 06: Ultrasonic Testing
Week 7, Feb 29	Lecture 07: Cont. Ultrasonic Testing
Week 8, March 07	**Midterm Exam** Lecture 08: Radiology
Week 9, March 22	Lecture 09: Radiology
Week 10, March 29	Lecture 10: Thermography
Week 11, April 5	Lecture 11: Acoustic Emission Testing Project Presentations
Week 12, April 12	Lecture 12: NDE Application, Project Presentations
Week 13, April 19	Lecture 13: Advanced Ultrasonic Testing Methods Phased Array Ultrasonic Testing (PAUT) Project Presentations
Week 14, April 26	Lecture 14: Project Presentations;
	Reading Days: May 1-2
Final Exam: May 03 - 09,	**Comprehensive Final Exam**

Course Objectives Matrix – CEE 638- 102

Strategies, Actions and Assignments	**ABET Student Outcomes (1-7)**	**Program Educational Objectives**	**Assessment Measures**
Student Learning Outcome 1: To define non-destructive testing and applications used in NDE			
Learn the basic principles and the method of application of the common NDE techniques	1, 2	1, 2	Lecture quizzes and class discussions
Be able to identify the types of equipment used for each NDE techniques	1, 2, 4,	1, 2	Lecture quizzes and class discussions
Student Learning Outcome 2: Discuss and learn the best applications, limitations and problems relating to the use of each NDE method.			
Learn the best applications, advantages and limitations of VT, MT, PT, UT, ET, RT and TT	4, 6, 7	1, 2	Lecture quizzes and class discussions
Describe, interpret, analyze and evaluate the defectology of metallic and nonmetallic materials;	5, 6, 7	1,2	Project, lecture quizzes and class discussions
Student Learning Outcome 3: Learn specific NDE methods for Civil Engineering			
Learn the best applications of NDE methods for CE such as GPR, PIT, and PDA, and for mechanical engineering, such as welds and composite materials inspection.	4, 6, 7	1, 2	Project, lecture quizzes and class discussions

CEE Mission, Program Educational Objectives and Student Outcomes

The mission of the Department of Civil and Environmental Engineering is:

- to educate a diverse student body to be employed in the engineering profession

- to encourage research and scholarship among our faculty and students
- to promote service to the engineering profession and society

Our Program Educational Objectives are reflected in the achievements of our recent alumni:

1. Engineering Practice: Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working toward safe, practical, sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.
2. Professional Growth: Alumni will advance their technical and interpersonal skills through professional growth and development activities such a graduate study in engineering, research and development, professional registration and continuing education; some graduates will transition into other professional fields such as business and law through further education.
3. Service: Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, charitable giving and other humanitarian endeavors.

Our Student Outcomes are what students are expected to know and be able to do by the time of their graduation:

1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies