Spring 2022

CE 638-102: Non-Destructive Testing Methods in Civil Engineering

Esmeralda Vataj

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

CE 638- Non-Destructive Testing methods in Civil Engineering

Course Syllabus – Spring 2022

Time: Thursdays 06:00 pm- 08:50 pm

Room: **FMH 313**

Delivery Mode: Face-to-Face (Delivery of instruction is structured around in-person classroom meeting times. Instruction is delivered in person and students are expected to attend class).

Instructor Information

Esmeralda Vataj, PhD
Office: 454 Tiernan Hall
Office Hour: Thursday 04:00 pm-06:00pm (in person or virtual), other times by appointment
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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

This course familiarizes the civil engineering student with non-destructive 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, analyse 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.

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 (10%)
    - Introduction and Background

- Applications

11. NDE Application (15%)
    - Mechanical Engineering
    - Civil Engineering

CE 638 Class Schedule for Spring 2022

Week of	Lecture Topics
Week 1, Jan 20	Lecture 01: Introduction to NDE
Week 2, Jan 27	Lecture 02: Visual Inspection
Week 3, Feb 3	Lecture 03: Liquid Penetrant Testing
Week 4, Feb 10	Lecture 04: Magnetic Particle
Week 5, Feb 17	Lecture 05: Eddy Current
Week 6, Feb 24	Lecture 06: Ultrasonic Testing
Week 7, March 3	Lecture 07: Ultrasonic Testing
Week 8, March 10	Exam 1 Lecture 08: Radiology
Week 9, March 24	Lecture 09: Radiology
Week 10, March 31	Lecture 10: Thermography
Week 11, April 7	Lecture 11: Acoustic Emission Testing
Week 12, April 14	Lecture 12: NDE Application
Week 13, April 21	Lecture 13: Project Presentations
Week 14, April 28	Lecture 14: Project Presentations; Review for final exam
	Reading Days: May 4-6
TBA	Lecture from invited NDT Expert and Visit in an NDT Company
Final Exam: May 6-12,	**Comprehensive final exam**

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 is 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 exam held during class time and one exam as scheduled by the University Registrar.

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

Project	15%
Quizzes	25%
Exam 1	27%
Exam 2	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).

Outcomes Course Matrix – NON-DESTRUCTIVE TESTING METHODS

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	4, 6, 7	1, 2	Project, lecture quizzes and class discussions

welds and composite materials inspection.			

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

Withdrawals:

In order to insure consistency and fairness in application of the NJIT policy on withdrawals, student requests for withdrawals after the deadline will not be permitted unless extenuating circumstances (e.g., major family emergency or substantial medical difficulty) are documented. The course Professors and the Dean of Students are the principal points of contact for students considering withdrawals.

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 he is unable to keep them; to provide a suitable guest lecturer when they are traveling; 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)

Legal Disclaimer: Students' ability to meet outcomes listed may vary, regardless of grade. They will achieve all outcomes if they attend class regularly, complete all assignments with a high degree of accuracy, and participate regularly in class discussions. This syllabus is subject to change at the discretion of the instructor throughout the term.

Spring 2022 Academic Calendar

January	17	Monday	Martin Luther King, Jr. Day
January	18	Tuesday	First Day of Classes
January	22	Saturday	Saturday Classes Begin
January	24	Monday	Last Day to Add/Drop a Class
January	24	Monday	Last Day for 100% Refund, Full or Partial Withdrawal
January	25	Tuesday	W Grades Posted for Course Withdrawals
January	31	Monday	Last Day for 90% Refund, Full or Partial Withdrawal, No Refund for Partial Withdrawal after this date
February	14	Monday	Last Day for 50% Refund, Full Withdrawal
March	7	Monday	Last Day for 25% Refund, Full Withdrawal
March	14	Monday	Spring Recess Begins - No Classes Scheduled - University Open
March	19	Saturday	Spring Recess Ends
April	4	Monday	Last Day to Withdraw

April	15	Friday	Good Friday - No Classes Scheduled - University Closed
April	17	Sunday	Easter Sunday - No Classes Scheduled - University Closed
May	3	Tuesday	Friday Classes Meet
May	3	Tuesday	Last Day of Classes
May	4	Wednesday	Reading Day 1
May	5	Thursday	Reading Day 2
May	6	Friday	Final Exams Begin
May	12	Thursday	Final Exams End
May	14	Saturday	Final Grades Due
May		TBA	Commencement