

SE 412 - FUNDAMENTALS OF NONDESTRUCTIVE EVALUATION (FALL 2023)

(CRN 68203, Section G, and CRN 68204, Section U)

(Tues-Thurs 3:30 pm-4:50 pm, Room 114 Transportation Building)

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Course Description: This course is designed to give seniors and first year graduate students in engineering an understanding of the basic physics and practice of key volumetric and surface inspection and nondestructive materials characterization technologies. The course is also designed to develop the students' familiarity with the current NDT&E literature, and to present the students with a philosophy of NDE such that rational decisions can be made for implementation.

Course Learning Goals: Prepare students to be able to plan and perform the nondestructive testing and evaluation of components using traditional methods such as: ultrasonics, radiography, magnetic particles, eddy currents etc. Students should also be familiar with current literature for a life-long learning process.

Textbook: "Nondestructive Evaluation - A Tool in Design, Manufacturing and Service," D.E. Bray and R.K. Stanley, CRC Press, Boca Raton, Florida, 1997.

NOTE: This is a very nice book for your own professional library. However, I am very pleased to inform you that you can have access to the electronic format of the textbook, which you can download, at the following link: <http://www.library.illinois.edu/proxy/go.php?url=https://www.taylorfrancis.com/books/9781498711050>.

If you use this link, you will be prompted for your NetID and password for access.

Lectures: The lectures will take place on Tuesdays and Thursdays from 3:30 pm to 4:50 pm in Room 114 of the Transportation Building.

Grading:

Section G		Section U	
One Quiz	30%	One Quiz	35%
Homework	30%	Homework	35%
Exam	25%	Exam	30%
Individual Technical Report and PPT Presentation.	15%	Extra credit: Technical Report or PPT Presentation	15%

Total Number of Hourly Lectures (Equivalent) ----- 43

Quiz----- 1 – To be announced.

Total Number of Hours----- 44

Final Examination ----- Monday, December 11, 7:00 pm – 10:00 pm.

Note: In addition, there is a project report to obtain the additional credit of one hour. Please note that one hour of credit will require between 3 and 4 hours on work outside of classroom.

Part I---Acoustic Techniques

OBJECTIVE: Understand why nondestructive testing and evaluation is needed for safety. Understand ultrasonic wave excitation and propagation characteristics, system operation and basic inspection methods. Introduction to Acoustic Emission.

	Hrs	TOPICS COVERED	Homeworks
08/21—08/25 08/28—09/01	6	Types of waves, wave speeds and characteristics	(Secs. 5.3 – 5.4). 5-1, 5.2, 5.3, 5-4
09/04-09/08	3	Snell's Law. Pulse characteristics, attenuation. Circuitry and transducers	(Secs. 5.6—5.7). (Secs. 7.1 –7.5) 5-5, 5-6, 5-7, 5-8
09/11-09/15	3	Inspection Principles and techniques. Effects of stress and texture.	(Chapter 8). 7-1, 7-2, 7-3
09/18-09/22	3	Introduction to Acoustic emission	(Secs. 21.5, 21.7). 8-1, 8-2, 8-3, 8-4

Part II---Radiography

OBJECTIVE: Understand Radiographic Techniques

	Hrs	TOPICS COVERED	Homeworks
09/25-09/29	3	Radiographic Sources and scattering	(Secs. 20.1 – 20.8.2). 28.2, 28.4, 28.6, 28.8, 28.10, 28.12
10/02-10/06	3	Radiographic image Inspection Systems Radiographic Inspections	(Chapter 21), Secs 22.1-22.4, (Chapter 23) 29.2, 29.4, 29.6, 29.8, 29.10, 29.12

10/09-10/13	3	Stress Measurements, tomography and neutron inspections, Safety in radiographic inspections	(Chapter 24), Secs. 25.1-25.2, 25.5, 25.7, (Chapter 26)	30.2, 30.4, 30.6, 30.8, 31.1
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Part III---Electromagnetic Techniques

OBJECTIVE: Understand Ferromagnetism, magnetic fields and forces, and methods of performing magnetic inspections. Introduction to eddy current methods.

	Hrs	TOPICS COVERED	Homeworks
10/16—11/20	3	Magnetic poles, forces and intensity	(Secs. 13.1 – 13.11). 13-2, 13-4, 13-6, 13-8, 13-10, 13-12, 13-14
10/23-11/27	3	Ferromagnetism Permeability Range of magnetic parameters in NDE	(Secs. 14.5.1—14.5.6). (Secs.14.8 and 15.7). (Sec. 14.9). 14-1, 14-2, 14-3, 14-4
10/30-11/03	3	Field intensity in straight wire Magnetic boundary conditions Magnetization with rods, coils and yokes Leakage fields from flaws Detection of leakage fields Demagnetization Eddy current methods	(Secs. 15.5 and 15.6). (Sec. 15.8). (Secs. 16.10 -- 16.12, 17.1 – 17.3.1). (Secs. 19.1 –19.3). (Secs. 21.5, 21.7). (Chapter 22). (Chapters 23, 24, 25, 26, and 27). 15-1, 15-2, 15-3, 15-8, 15-9, 15-10, 23-3

Part IV---Liquid Penetrant Inspection

OBJECTIVE: Understand Liquid Penetrant Inspection Techniques

	Hrs	TOPICS COVERED	Homeworks
11/06—11/10	3	Liquid Penetrant Inspections, Safety in Penetrant Inspection	(Chapters 27, 28, 29, and 30). 34.1, 34.2, 34.4, 35.4, 36.3, 37.1, 37.2

Part V---Probability, Inspections and Risk

OBJECTIVE: learn the Why and How of NDT&E in general and how it applies to engineering; probability of detection.

	Hrs	TOPICS COVERED	Homeworks
11/13-11/17	3	Probabilities, Flaw distributions, and Data Set characteristics. Effect of NDT in Design, failure rate and reliability; Flaw characteristics and effect of material properties; design for inspectability. Operator and Systems Performance, Effect of NDE on manufacturing and maintenance costs; Probability inspection and failure; Risk Based Inspection and fitness-for-service analysis.	(Chapter 2); (Chapter 3) (Chapter 4) 2.7, 2.8, 3.1, 3.4, 4.3, 4.4, 4.5, 4.6, 4.7

(11/20—11/24) ----- Thanksgiving Break

Part VI---Other NDT techniques

OBJECTIVE: learn about other NDT techniques such as Shearography, thermal image, acoustic resonance, etc.

	Hrs	TOPICS COVERED	Homeworks
11/27-12/01 12/04-12/06	7	Shearography, Thermal Image, Acoustic Resonance etc. Review	

Other References

- *Nondestructive Evaluation -- "Theory, Techniques, and Applications,"* Ed., Petter J. Shull, Marcel Dekker, Inc., NY, 2002.
- *"Ultrasonic Waves in Solid Media,"* Joseph L. Rose, Cambridge University Press, Cambridge, UK, 1999.
- *"Non-Destructive Testing,"* R. Halmshaw, Edward Arnold Publishing Co., Baltimore, Maryland, 1987.
- *"Nondestructive Testing Handbook,"* Vol. 1&2, R.C. McMaster, ASNT, Columbus, Ohio, 1959.
- *"Nondestructive Testing Handbook Series,"* ASNT, Columbus, Ohio, 1985.
- *"9th Edition Metals Handbook,"* Volume 17, ASM, Materials Park, Ohio, 1992.
- *Ultrasonic Measurements for Process Control - Theory, Techniques, Applications,"* L. C. Lynnworth, Academic Press, Inc., New York, N.Y., 1989.
- *"Ultrasonic Testing,"* S. Szilard, ed., John Wiley, New York, 1982.
- *"Ultrasonics - Fundamentals, Technology and Applications,"* Dale Ensminger, Marcel Dekker, 1988.
- *"Radiographic NDT,"* Edited by L. Becker, E.I. du Pont de Nemours & Co., Inc., Wilmington, DE, 1990.

Technical Journals

- *ASME Journal of Nondestructive Evaluation, Diagnosis and Prognosis of Engineering Systems*
- *Materials Evaluation*
- *British Journal of Non-Destructive Testing*
- *Journal of Acoustic Emission*
- *Research in Nondestructive Evaluation*
- *NDT International*
- *Ultrasonics*

Tips for Success

To do well in the course, please remember the following:

- Do your work frequently. If you let the work pile up, you may become overwhelmed.
- Consider using a word processor to save all your work so that you have an automatic back up of all your assignments. This will be useful in an unlikely event that your computer/served goes down and you are unable to submit your work.
- It is very important that you communicate throughout the course. Should you have difficulties with some work or are going to be away because of illness or a family emergency (or similar difficulties), please inform the instructor as soon as possible. This will keep the instructor from worrying about your whereabouts.
- When possible provide tips and suggestions to your peers in the class. As a learning community, we can help each other learn and grow. One way of doing this is by helping to address the questions that your peers pose. By engaging with each other, we will all learn better.

Request for special Accommodations

If you require special accommodations, please contact the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak Street, Champaign, call 217.333.4603, or email disability@illinois.edu. Please note accommodations are not retroactive to the beginning of the semester, but begin the day you contact your professor with a current letter of accommodation from DRES.

Emergency Dean

"Help is only a phone call away." A university-wide Emergency Dean is always available to provide you with personal assistance in times of emergency, such as serious illnesses, hospitalizations, accidents, deaths or other major crises. Emergency Dean Service: 217-333-0050.

Statement Regarding Anti-Racism/Diversity & Inclusion

The Grainger College of Engineering is committed to the creation of an anti-racist, inclusive community that welcomes diversity along a number of dimensions, including, but not limited to, race, ethnicity and national origins, gender and gender identity, sexuality, class and religion. All students should be treated with respect, so that they can live and learn without marginalization and racism being instigated by other members of our community. Both overt racism and the micro-aggressions threaten inclusivity and hence, have no place at the University of Illinois.

The effectiveness of this course is dependent upon each of us to create a safe and encouraging learning environment that allows all students equitable opportunities and respect. All of us are expected to help establish and maintain an environment where you and your peers can contribute without fear of ridicule or intolerant or offensive language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, I encourage you to bring this to my attention if you feel comfortable. You can also report these behaviors to the Office for Student Conflict Resolution (<http://www.conflictresolution.illinois.edu/>), or to the Bias Assessment and Response Team (BART) (<https://bart.illinois.edu/>). Based on your report, the staff will reach out to students to make sure they have the support they need to be healthy and safe.

Statement for Professional/Respectful Zoom Activities/Chats

It is imperative to creating a productive learning environment that we practice constructive discourse when in class. This entails respecting your fellow classmates, exhibiting a willingness to listen, and tolerating opposing points of view. Our discussions will center on the integrity of how our topics are being argued, not whether or not you necessarily agree with your classmate's topic or stance. If you argue aggressively, are rude, or are unproductively critical, you will be asked to leave and will be marked absent for that day.

Teaching Responses

Assignments are hand graded, thus, please allow 1-2 weeks for complete grading of these assessments. We will respond to e-mail messages and phone calls within 24 hours of receiving them Monday through Friday 9:00 to 5:00 p.m. central time. Saturdays and Sundays, we will continue to check email, but response time may take up to 48 hours. If you leave a message, please check your e-mail for a response. Email should always be the first communication approach.

Academic Integrity Statement

The University of Illinois at Urbana-Champaign Student Code should be considered as a part of this syllabus. Students should pay particular attention to article 1, part 4: Academic Integrity. Read the Code at the following URL: <http://studentcode.illinois.edu/>. Academic dishonesty may result in a failure grade. Every student is expected to review and abide by the Academic Integrity Policy <http://studentcode.illinois.edu/>. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt what constitutes plagiarism, cheating, or any other breach of any academic integrity.

Emergency Response

Emergency response recommendations can be found at the following website: <http://police.illinois.edu/emergency-preparedness/>. I encourage you to review this website and the campus building floor plans website within the first 10 days of class. <http://police.illinois.edu/emergency-preparedness/building-emergency-action-plans/>.

Statement on Family Education Rights and Privacy Act (FERPA)

Any student who suppressed their directory information pursuant to Family Education Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of privacy of their attendance in this course. See <http://registrar.illinois.edu/academic-records/ferpa/> for more information on FERPA.

Statement on Accommodations — Enhanced Statement with Resources

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, email disability@illinois.edu or go to DRES website. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available on campus that can help diagnosis a previous undiagnosed disability by visiting DRES website and selecting “sign-Up for an Academic Screening” at the bottom of the page.

Statement on Sexual Misconduct and Reporting

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to University’s Title IX and Disability Office. In turn, any individual with Title IX and Disability Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and maintain confidentiality can be found here: <http://wecare.illinois.edu/resources/students/#confidential>. Other information about resources is available here: <http://wecare.illinois.edu>.

Statement when Using the NET (Netiquette Statement):

In any social interactions, certain rules of etiquette are expected and contribute to more enjoyable and productive communications. The following are tips for interacting online via email or discussing board messages, adapted from guidelines originally compiled by Chuq Von Rospach and Gene Spafford (1995):

- Remember that the person receiving your message is someone like you, deserving courtesy and respect.
- Avoid typing all sentences or phrases in Caps Lock
- Be brief; succinct, thoughtful messages have the greatest effect.
- Your messages reflect your personality; take time to make sure that you are proud of their form and content
- Use descriptive subject headings in your e-mails
- Think about your audience and the relevance of your messages.
- Be careful when you use humor and sarcasm; absent the voice inflections and body language that aid face-to-face communication, Internet messages are easy to misinterpret
- When making follow-up comments, summarize the parts of the message to which you are responding
- Avoid repeating what has already been said.; needless repetition is ineffective communication
- Cite appropriate references whenever using someone else’s ideas, thoughts, or words.

Statement Regarding Copyright

Material associate to this course, (i.e., SE412) has been developed solely for the students enrolled in this course. Use of this material by anyone associated with SE412 course violates Copyright, and the person or persons may be subjected to the Ethics code of Conduct from the University of Illinois at Urbana-Champaign.