

GE 412 - FUNDAMENTALS OF NONDESTRUCTIVE EVALUATION (FALL 2016)

(CRN 65208, Section G, and CRN 65208, Section U)

(Tues-Thurs 2:00 pm-3:20 pm, Room 106B1 of Engineering Hall)

Professor Henrique Reis; Office: 217 Transp. Bldg.; Phone: 333-1228; email: h-reis@illinois.edu

Goals:

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 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.

Grading			
Section G		Section U	
One Quiz	25%	One Quiz	35%
Homework	20%	Homework	35%
Final Exam	30%	Final Exam	30%
Tech. Report or PowerPoint Presentations	25%		

Textbook:

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

Other References:

- "Non-Destructive Testing," R. Halmshaw, Edward Arnold Publishing Co., Baltimore, Maryland, 1987.
- "Nondestructive Testing," W.J. McGonagle, Gordon and Breach Science Publishers, New York, NY, 1961.
- "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 Testing of Materials," Third Edition, J. & H. Krautkramer, Springer-Verlag, Berlin, 1983.
- "Ultrasonic Measurements for Process Control - Theory, Techniques, Applications," L. C. Lynnworth, Academic Press, Inc., New York, N.Y., 1989.
- "Ultrasonic Transducers for Nondestructive testing," M.G. Silk, Adam Hilger, Bristol, UK, 1984.
- "Ultrasonic Investigation of Materials Properties, Treatise on Materials Science and Technology," Vol. 3, Robert E. Green, Jr., Academic Press, 1973.
- "Ultrasonic Testing," S. Szilard, ed., John Wiley, New York, 1982.
- "Ultrasonics - Fundamentals, Technology and Applications," Dale Ensminger, Marcel Dekker, 1988.
- "Basic Physics in Diagnostic Ultrasound," Joseph L. Rose and Barry B. Goldberg, John Wiley, New York, 1979
- "The Excitation and Propagation of Elastic Waves," J.A. Hudson, Cambridge University Press, Cambridge, UK, 1980.
- "Electrical, Magnetic, and Visual Methods of Testing Materials," J. Blitz, Butterworth & Co. LTD., London, 1969.
- "Introduction to Electromagnetic Nondestructive Test Methods," H. L. Libby, R. E. Krieger Publishing Co., Malabar, Florida, 1979.
- "Radiographic NDT," Edited by L. Becker, E.I. du Pont de Nemours & Co., Inc., Wilmington, DE, 1990.

Technical Journals:

- *Materials Evaluation*
- *British Journal of Non-Destructive Testing*
- *Journal of Acoustic Emission*
- *Research in NDT*
- *NDT International*
- *Ultrasonics*

Part I---Acoustic Techniques				
OBJECTIVE: Understand ultrasonic wave excitation and propagation characteristics, system operation and basic inspection methods. Introduction to Acoustic Emission.				
	Hrs	TOPICS COVERED		Homeworks
08/22—08/26 08/29—09/022	6	Types of waves, wave speeds and characteristics	(Secs. 5.3 – 5.4).	5-1, 5.2, 5.3, 5-4
09/05-09/09	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
09/12-09/16	3	Inspection Principles and techniques. Effects of stress and texture.	(Chapter 8).	7-1, 7-2, 7-3
09/19-09/23	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
09/25-09/30	3	Radiographic Sources and scattering	(Secs. 20.1 – 20.8.2).	28.2, 28.4, 28.6, 28.8, 28.10, 18.12
10/02-10/07	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
10/09-10/14	3	Stress Measurements, tomography and neuron 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

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—10/21	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
10/23-10/28	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
10/30-11/04	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—11/11	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
11/13-11/18	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

(11/21-11/25) ----- Thanks Giving

Part VI---Other NDT techniques			
OBJECTIVE: learn about other NDT techniques such as Shearography, thermal image, acoustic resonance, etc.			
	Hrs	TOPICS COVERED	Homeworks
11/27-12/07	3	Shearography, Thermal Image, Acoustic Resonance etc.	

Total Number of Hourly Lectures (Equivalent) ----- 41
Quiz----- 1
Total Number of Hours----- 43

Note: In addition, there is a project report to obtain the additional credit of one hour.