Eddy Current Level I – II Course Outline (40hrs)

NDT overview and certification requirements

Introduction to Electromagnetic Testing
(Eddy Current/Flux Leakage)
a. Brief history of testing
b. Basic principles of testing

Electromagnetic Theory
a. Eddy current theory
(1) Generation of eddy currents by means of an AC field
(2) Effect of fields created by eddy currents (impedance changes)
(3) Effect of change of impedance on instrumentation
(4) Properties of eddy current
(a) Travel in circular direction
(b) Strongest on surface of test material
(c) Zero value at center of solid conductor placed in an alternating magnetic field
(d) Strength, time relationship, and orientation as functions of test- system parameters and test-part characteristics
(e) Have properties of compressible fluids
(f) Small magnitude of current flow
(g) Relationship of frequency and plane with current in coil
(h) Effective permeability variations when induced in magnetic materials
(i) Effect of discontinuity orientation
(j) Power losses
b. Flux leakage theory
(1) Terminology and units
(2) Principles of magnetization
(a) B-H curve
(b) Magnetic properties
(c) Magnetic field
(d) Hysteresis loop
(e) Magnetic permeability
(f) Factors affecting permeability
(3) Magnetization - electromagnetism theory
(a) Oersted's law
(b) Faraday's law
(c) Electromagnetics

Readout Mechanism
a. Meter
b. Impedance plane
c. LED bar graph
d. Alarm, lights, etc.
e. Numerical
f. Marking system

g. Strip chart recorder

Types of Eddy Current Sensing Elements

a. Probes
    (1) Types of arrangements
        (a) Absolute
        (b) Differential
    (2) Lift-off
    (3) Theory of operation
    (4) Applications
    (5) Advantages
    (6) Limitations

b. Through, encircling, or annular coils
    (1) Types of arrangements
        (a) Absolute
        (b) Differential
    (2) Fill factor
    (3) Theory of operation
    (4) Applications
    (5) Advantages
    (6) Limitations

c. Factors affecting choice of sensing elements (1) Type of part to be inspected
    (2) Type of discontinuity to be detected
    (3) Speed of testing required
    (4) Amount of testing required
    (5) Probable location of discontinuity

Applications for Eddy Current Testing

a. Aerospace
b. Tubing inspection (power plant)
c. Rod, wire, tube inspection (Manufacturing)

Types of Abnormalities detected by ET

a. Conductivity testing
b. Crack detection (Surface and sub-surface)
c. Corrosion detection
d. Overheated structure
e. Coating thickness
f. Metal thinning

Practical demonstrations and exercises

Summary/Final review

Eddy Current Level I End of course test and review

Eddy Current Level II

Review of Electromagnetic Theory

a. Eddy current theory
b. Flux leakage theory
c. Types of eddy current sensing probes

Factors That Affect Coil Impedance

a. Test part
    (1) Conductivity
    (2) Permeability
    (3) Size and shape
    (4) Homogeneity
b. Test System
    (1) Frequency
    (2) Coupling
    (3) Field strength
    (4) Test coil and shape

Factors That Affect Flux Leakage Fields

a. Degree of magnetization
b. Defect geometry
c. Defect location
d. Defect orientation
e. Velocity factor
f. Distance between adjacent fields

Signal-to-Noise Ratio

a. Definition
b. Relationship to eddy current testing
c. Methods of improving signal-to-noise ratio
d. Description of the theory and use of filters

Selection of Test Frequency

a. Relationship of frequency to type of test
b. Considerations affecting choice of test
    (1) Signal-to-noise ratio
    (2) Phase discrimination
    (3) Response speed
    (4) Skin effect
    (5) Standard depth of penetration
    (6) Effective depth of penetration
    (7) Type and size of flaws sought

The Impedance plane diagram

A comprehensive explanation of its construction
Detailed explanations of how to use it to determine:
a. Frequency
b. Phase angle
c. Gain (Vertical and horizontal ratios)
d. Probe choice

Coupling
a. "Fill factor" in through-coil inspection
b. "Lift-off" and compensation in probe coil inspection
c. "Lift-off' in non conductive coating measurement

Field Strength and Its Selection
a. Permeability changes
b. Saturation
c. Effect of AC field strength on eddy current testing
d. Effect of field strength in flux leakage testing

Instrument Design Considerations
a. Amplification
b. Phase detection
c. Differentiation of filtering

Applications
a. Flaw detection (Surface and sub surface)
b. Sorting for properties related to conductivity
a. Sorting for properties related to permeability
d. Thickness evaluation coatings
e. Thickness evaluation metals
f. Corrosion detection/quantification
g. Dual frequency techniques
h. Second layer techniques
i. Rotary bolt hole inspection
j. Ring probe fastener hole inspection
k. C-scan applications

Latest developments in Eddy Current instruments

Practical demonstrations and exercises in the above techniques

Review

End of course test and review