**Course Number:** NDT 120

**Instructor**: Zak Milligan

**Email**: milligz@linnebenton.edu

**Office Hours:** TBA or by appointment, Monday through Friday

**Prerequisite**: None

**Important Dates: Important Dates:** November 11, 2019 Veteran’s Day

November 28 and 29 Thanksgiving

December 2-5 Finals Week

Textbooks: NDT Handbook Volume 3 - Penetrant Testing - ASNT & NDT Handbook Volume 3 – Magnetic Particle Testing (not required but on reserve in Library)

Topics:

**Liquid Penetrant Testing Level I**

1. **Introduction**
   1. Brief history of nondestructive testing and liquid penetrant testing
   2. Purpose of liquid penetrant testing
   3. Basic principles of liquid penetrant testing
   4. Types of liquid penetrants commercially available
   5. Methods of personnel qualification
2. **Liquid Penetrant Processing**
   1. Preparation of parts
   2. Adequate lighting
   3. Application of penetrant to parts
   4. Removal of surface penetrant
   5. Developer application and drying
   6. Inspection and evaluation
   7. Post-cleaning
3. **Various Penetrant Testing Methods**
   1. Current ASTM and ASME standard methods – ASTM E 165, E 1208, E 1209, E 1210, and E 1417
   2. Characteristics of each method
   3. General applications of each method
4. **Liquid Penetrant Testing Equipment**
   1. Liquid penetrant testing units
   2. Lighting for liquid penetrant testing equipment and light meters
   3. Materials for liquid Penetrant testing

**Liquid Penetrant Testing Level II**

1. **Review**
   1. Basic principals
   2. Process of various methods
   3. Equipment
2. **Selection of the appropriate penetrant testing method**
   1. Advantages of various methods
   2. Disadvantages of various methods
3. **Inspection and evaluation of the indications**
   1. General
      1. Discontinuities inherent in various materials
      2. Reason for indications
      3. Appearance of indications
      4. Time for indications to appear
      5. Persistence of indications
      6. Effects of temperature and lighting (white to UV)
      7. Effects of metal smearing operations (shot, peening, machining, etc.)
      8. Preferred sequence for penetrant inspection
      9. Part preparation (pre-cleaning, stripping, etc.)
   2. Factors affecting indications
      1. Pre-cleaning
      2. Penetrant used
      3. Prior processing
      4. Technique used
   3. Indications from cracks
      1. Cracks occurring during solidification
      2. Cracks occurring during processing
      3. Cracks occurring during service
   4. Indications from porosity
   5. Indications from specific material forms
      1. Forgings
      2. castings
      3. plate
      4. Welds
      5. extrusions
   6. Evaluation of indications
      1. True indications
      2. False indications
      3. Relevant indications
      4. Nonrelevant indications
      5. Process control
         1. Controlling process variables
         2. Testing and maintenance materials
4. **Inspection procedures and standards**
   1. inspection procedures (minimum requirements)
   2. standards/codes
      1. applicable methods/processes
      2. acceptance criteria
5. **Basic methods of instruction**

**Magnetic particle testing level I**

1. **Principles of magnets and magnetic fields**
   1. Theory of magnetic Fields
      1. Earth’s magnetic field
      2. Magnetic fields around magnetized materials
   2. Theory of magnetism
      1. Magnetic poles
      2. Law of magnetism
      3. Materials influenced by magnetic fields
         1. Ferromagnetic
         2. Paramagnetic
      4. Magnetic characteristics of nonferrous materials
   3. Terminology associated with magnetic particle testing
2. **Characteristics of Magnetic Fields**
   1. Bar magnet
   2. Ring magnet
3. **Effect of Discontinuities of Materials**
   1. Surface cracks
   2. Scratches
   3. Subsurface defects
4. **Magnetization by Means of Electric Current**
   1. Circular field
      1. Field around a straight conductor
      2. Right hand rule
      3. Fields in parts through which current flows
         1. Long, solid, cylindrical, regular parts
         2. Irregularly shaped parts
         3. Tubular parts
         4. Parts containing machine holes, slots, etc.
      4. Methods of inducing current flow in parts
         1. Contact plates
         2. Prods
      5. Discontinuities commonly discovered by circular fields
   2. Longitudinal field
      1. Field produced by current flow in a coil
      2. Field direction in a current-carrying coil
      3. Field strength in a current-carrying coil
      4. Discontinuities commonly discovered by longitudinal fields
      5. Advantages of longitudinal magnetization
      6. Disadvantages of longitudinal magnetization
5. **Selecting the Proper Method of Magnetization**
   1. Alloy, shape and condition of part
   2. Type of magnetizing current
   3. Direction of magnetic field
   4. Sequence of operations
   5. Value of flux density
6. **Inspection Materials**
   1. Wet particles
   2. Dry particles
7. **Principles of Demagnetization**
   1. Residual magnetism
   2. Reasons for requiring demagnetization
   3. Longitudinal and circular residual fields
   4. Basic principles of demagnetization
   5. Retentivity and coercive force
   6. Methods of demagnetization
8. **Magnetic Particle Testing Equipment**
   1. Equipment selection considerations
      1. Type of magnetizing current
      2. Location and nature of test
      3. Test materials used
      4. Purpose of test
      5. Area inspected
   2. Manual inspection equipment
   3. Medium and heavy-duty equipment
   4. Stationary equipment
   5. Mechanized inspection equipment
      1. Semiautomatic inspection equipment
      2. Single-purpose semiautomatic equipment
      3. Multipurpose semiautomatic equipment
      4. Fully automatic equipment
9. **Types of Discontinuities Detected by Magnetic Particle Testing**
   1. Inclusions
   2. Blowholes
   3. Porosity
   4. Flakes
   5. Cracks
   6. Pipes
   7. Laminations
   8. Laps
   9. Forging bursts
   10. Voids
10. **Magnetic Particle Test Indications and Interpretations**
    1. Indications of nonmetallic inclusions
    2. Indications of surface seams
    3. Indications of cracks
    4. Indications of laminations
    5. Indications of laps
    6. Indications of bursts and flakes
    7. Indications of porosity
    8. Nonrelevant indications

**Magnetic particle testing level II**

1. **Principles**
   1. Theory
      1. Flux patterns
      2. Frequency and voltage factors
      3. Current calculations
      4. Surface flux strength
      5. Subsurface effects
   2. Magnetics and magnetism
      1. Distance factors versus strength of flux
      2. Internal and external flux patterns
      3. Phenomenon action at the discontinuity
      4. Heat effects on magnetism
      5. Materials hardness versus magnetic retention
2. **Flux Fields**
   1. Direct current
      1. Depth of penetration factors
      2. Source of current
   2. Direct pulsating current
      1. Similarity to direct current
      2. Advantages
      3. Typical fields
   3. Alternating current
      1. Cyclic effects
      2. Surface strength characteristics
      3. Safety precautions
      4. Voltage and current factors
      5. Source of current
3. **Effects of Discontinuities on Materials**
   1. Design factors
      1. Mechanical properties
      2. Part use
   2. Relationship to load-carrying ability
4. **Magnetization by Means of Electric Current**
   1. Circular techniques
      1. Current calculations
      2. Depth-factor considerations
      3. Precautions – safety and overheating
      4. Contact prods and yokes
         1. Requirements for prods and yokes
         2. Current-carrying capabilities
      5. Discontinuities commonly detected
   2. Longitudinal technique
      1. Principles of induces flux fields
      2. Geometry of part to be inspected
      3. Shapes and sizes of coils
      4. Use of coils and cables
         1. Strength of field
         2. Current directional flow versus flux field
         3. Shapes, sizes, and current capabilities
      5. Current calculations
         1. Formulas
         2. Types of current required
         3. Current demand
      6. Discontinuities commonly detected
5. **Selecting the Proper Method of Magnetization**
   1. Alloy, shape, and condition of part
   2. Type of magnetizing current
   3. Direction of magnetic field
   4. Sequence of operations
   5. Value of flux density
6. **Demagnetization Procedures**
   1. Need for demagnetization of parts
   2. Current, frequency, and field orientation
   3. Heat factors and precautions
   4. Need for collapsing flux fields
7. **Equipment**
   1. Portable type
      1. Reason for portable equipment
      2. Capabilities of portable equipment
      3. Similarity to stationary equipment
   2. Stationary type
      1. Capability of handling large and heavy parts
      2. Flexibility in use
      3. Need for stationary equipment
      4. Use of accessories and attachments
   3. Automatic type
      1. Requirements for automation
      2. Sequential operations
      3. Control and operation factors
      4. Alarm and rejection mechanisms
   4. Multidirectional units
      1. Capability
      2. Control and operation factors
      3. Applications
   5. Liquids and powders
      1. Liquid requirements as a particle vehicle
      2. Safety precautions
      3. Temperature needs
      4. Powder and paste contents
      5. Mixing procedures
      6. Need for accurate proportions
   6. Ultraviolet radiation type
      1. Ultraviolet radiation and florescence
      2. Visible light and black light comparisons
      3. Requirements in the testing cycle
      4. Techniques in use
   7. Light-sensitive instruments
      1. Need for instrumentation
      2. Light characteristics
8. **Types of Discontinuities**
   1. In castings
   2. In ingots
   3. In wrought sections and parts
   4. In welds
9. **Evaluation techniques**
   1. Use of Standards – e.g., ASTM E 1444, E 709
      1. Need for standards and references
      2. Comparison of known with unknown
      3. Specifications and certifications
      4. Comparison techniques
   2. Defect appraisal
      1. History of part
      2. Manufacturing process
      3. Possible causes of defect
      4. Use the part
      5. Acceptance and rejection criteria
      6. Use of Tolerances
10. **Quality Control of Equipment and Processes**
    1. Malfunctioning of equipment
    2. Proper magnetic particles and bath liquid
    3. Bath concentration
       1. Settling test
       2. Other bath-strength tests
    4. Tests for ultraviolet radiation intensity

**11.0 Course Evaluation:**

* Attendance approx. **25%**
* Assignments, notes, quizzes, activities approx. **50%**
* Tests approx. **25%**

**Attendance:**

The number 1 reason employees are fired in the manufacturing industry is attendance and tardiness, consequently, our industry partners request that we hold our students accountable for attendance and punctuality. Daily points are given for attendance, tardiness and work ethic. Your maximum overall course percentage/grade may not exceed your overall attendance percentage/grade.

Students who may need accommodations due to documented disabilities, who have medical information that the instructor should know, or who need special arrangements in an emergency should speak with their instructor during the first week of class. If you believe you may need accommodations but are not yet registered with the Center for Accessibility Resources (CFAR), please visit the [CFAR Website](http://www.linnbenton.edu/cfar) for steps on how to apply for services or call 541-917-4789.

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