

1. Module Details	
Module name	EDDY CURRENT TESTING
Nominal duration	3 modules It is anticipated that a learner holding the prescribed entry level skills will achieve the module purpose in 100 to 120 hours
Module Codes	EA605
Discipline Code	Non-destructive testing (Code to be allocated)
2. Module Purpose	The purpose of this module is to provide an understanding of the principles of eddy current testing, to enable students to operate eddy current equipment and interpret signals indicated by the equipment, and to use eddy current test procedures in industrial applications.
3. Prerequisites	Nil
4. Relationship to competency standards	This module meets the training requirements for Level 2 qualification in eddy current testing under AS3998-1992 "Non-destructive Testing - Qualification and Certification of Personnel - General Engineering" and AS-3669-1989 "Non-Destructive Testing - Qualification and Registration of Personnel - Aerospace". Currently no national competency standards have been established at national level. However, the learning outcomes in this course relate to ASF level 5-6.
5. Content	Basic Principles of eddy current and electromagnetic testing Electricity Direct current, amperage, voltage Ohms law & resistance, conductivity & resistivity Alternating current Amplitude, phase, impedance, vectorial representation Electromagnetic induction Field generated by a current Field/induction relationship Flux of induction vector EMF of induction Self-inductance - coefficient of self inductance Mutual inductance - coefficient of mutual inductance inductance Coupling coefficient Impedance of a circuit in presence of another circuit Representation of impedance plane Effect of fill factor Normalised impedance plane Effect of frequency Influence of magnetic field Magnetism

	<p>Magnetic data Induction & magnetic fields Magnetic permeability Iron magnetisation Induced magnetic flux Lines of force and force fields Flux conservation, residual magnetism Magnetic ohm law Magnetomotive force Reluctance Magnetic circuits Electromagnetism Magnetic field produced by a current Inductive current - eddy current Reactance - field made by eddy current Biot & Savant law - Definition, practical (Right Hand) rules Amperes law - Definition, applications (toroid, infinite coil, flat coil) Lenz law - Definition, auto-induction factor, mutual induction factor, coupling factor Induced currents - in short circuit coil, in a metallic mass Skin effect Reactance (field produced by eddy current) Theory of eddy currents Distribution of eddy currents Plane conductors - Effect of amplitude and phase, depth of standard penetration Defect reaction according to its position Cylindrical bars - Similarity Law Characteristic frequency Variation of amplitude and currents Depth of standard penetration, Defect reaction according to its position Tubes - Characteristic frequencies Variations in amplitude and phase of currents Depth of standard penetration Defect reaction according to its position Geometric defect characterisation - Hypothesis of interrupted current Point defects Large defects Multiple defects Impedance diagrams - Encircling coil with bar, tube or sphere Operating points, choice Use of impedance diagrams</p>
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Characteristics of eddy current probes

Induction and reception functions

Absolute and differential measure,

Types of probes, encircling, internal, surface, hybrid

Means of focussing

Field from an empty coil, divergence between theory & practice

Effect of coupling

Remote field techniques

Magneto-optical imaging

EC distribution related to coil position

Field generated by non-load inductor

EC path in product according to its position towards inductor coil

Distance influence on coupling in various shapes

Probe reactance to small, long and continuous defects

Design technology, manufacturing technology, electric parameters, maintenance

Eddy Current Equipment

Working principles

Transmission, reception, data presentation

Equipment controls

Oscillator - frequency control

Energising devices and measurement

Balancing the system

Amplifier, filter, modulation/demodulation

Phase rotation

Display - ellipse, A-scan, vector point

Gain control

Types of equipment

mono-parameter, mono-channel

Multi-parameter, multi-channel

Auxiliary devices

Signal acquisition, saturation magnetiser/demagnetiser, signal storage, recorders, memories, data processing.

Properties of materials

Physical properties

Electrical conductivity - effect of chemical analysis, temperature, grain size, texture, cold work, structure

Magnetic permeability - effect of chemical analysis temperature, grain size, texture, cold work, structure

Hysteresis loop, Rayleigh area, saturation, Weiss area, Curie point.

Anomalies relating to manufacture and service

Applications of eddy current testing

Influence of various parameters on eddy current measurement

Defect position and orientation

EC path, penetration depth, zone of probe action

Material temperature

	<p>Heating, deviations, compensation Structure and geometry of test part Choice of frequency, phase discrimination, noise filtering, magnetic saturation Coupling influence Vibrations, centering, fill factor, sensitivity, compensation. Relative speed Testing frequencies according to speed Band width of apparatus according to test speed</p>
6. Assessment strategy	Competency based assessment applies. Assessment should be carried out by gathering evidence using a variety of methods or instruments that have validity according to the learning being assessed.
Assessment method	<p>Multiple choice and short answer questions. Written assignments and demonstrated competence through assigned tasks.</p> <p>Final assessment will be by a written examination and practical examination as required by AS3998 for Level 2 Certification.</p>
Conditions of assessment	Assessment will be conducted by suitably qualified assessors, as required by AS3998. The candidate will have access to any equipment, materials and documentation as required for the assessment.
7. Learning outcome details	On completion of this module, the learner will be able to
8. Learning outcome 1	Describe the basic principles of eddy current testing
Assessment criteria	<p>1.1 Explain the physics of electricity and magnetism as it applies to eddy current testing.</p> <p>1.2 Explain the physics of electromagnetism.</p> <p>1.3 Discuss the relevant laws of electromagnetism and electromagnetic induction in relation to the production of eddy currents.</p>
Learning outcome 2	Describe the theory of eddy currents.
Assessment criteria	<p>2.1 Describe how eddy currents are distributed in sheet, plate, bars and tubes.</p> <p>2.2 Describe how defects may be characterised for eddy current</p>

	determination. 2.3 Explain the use of impedance diagrams in eddy current testing.
Learning outcome 3	Describe the characteristics of eddy current probes.
Assessment criteria	3.1 Describe the induction and reception functions of eddy current probes. 3.2 Discuss the features and applications of absolute and differential probes. 3.3 Illustrate the design technology and manufacturing technology of eddy current probes.
Learning outcome 4	Understand the principles and to set up, calibrate and use eddy current test equipment for the inspection of materials and components
Assessment criteria	4.1 Describe the principles of the operation of eddy current equipment 4.2 Set up and calibrate the various types of eddy current equipment 4.3 Use eddy current equipment for inspection of materials and components for thickness gauging, flaw detection, and conductivity.
Learning outcome 5	Describe the applications for eddy current testing, including the materials and products that may be tested by this method and the nature of the defects that may be detected
Assessment criteria	5.1 Describe the electromagnetic properties of materials that affect their suitability to eddy current testing and the effect of variations in electromagnetic properties on the test outcomes 5.2 Describe and identify the main types of defects and discontinuities that may be detected by eddy current testing. 5.3 Describe the discontinuities in materials that may result from method of manufacture or service.
Learning outcome 6	Discuss and assess the influence of various parameters on the eddy current test.
Assessment criteria	6.1 Describe how parameters such as defect orientation and position, structure, shape, coupling and test speed may influence the

	<p>technique and outcome of eddy current testing.</p> <p>6.2 Assess and report on the effect of various parameters on the test outcomes.</p>
7. Delivery of the module	This module may be taught by active participation, illustration, demonstration and description. This module is practical in nature and theoretically integrated to complement the acquisition of practical skills.
Delivery strategy	<p>This module may be taught and assessed on or off-the-job.</p> <p>The module has a high practical content. Theory and practice will be taught concurrently. There will be a range of learning activities including modified lectures, practical work and project work.</p>
Resource requirements	<p>Human resources</p> <ul style="list-style-type: none"> • trainer/teacher/mentor <p>Physical resources</p> <ul style="list-style-type: none"> • appropriately equipped training room • relevant equipment and information • legislative and regulatory documents •
Major texts and references	<p><u>RECOMMENDED TEXT</u></p> <p>Introduction to Electromagnetic Test Methods, H. Libby. Robert E Kreiger Pub. 1971.</p> <p><u>PRACTICAL TEXT</u></p> <p>Practical Electromagnetic Testing (In preparation).</p> <p><u>REFERENCES</u></p> <ol style="list-style-type: none"> 1. Non-Destructive Testing Handbook, 2nd Edition, Vol 4, Electromagnetic Testing. ASNT, 1986. 2. Fundamentals of Eddy Current Testing. D.J. Hagemaiier. ASNT, 1990. 3. Eddy Current Testing Classroom Training Handbook. ASNT. 4. Eddy Current Testing, Cecco, Van Drunen, Sharp. GP Courseware, 1987. <p><u>STANDARDS</u></p>

	<p>AS 2084 NDT - Methods for Eddy Current Testing of Metal Bar and Tubular Products.</p> <p>NOTE: Reference should also be made to various codes and standards for defect limitations as revealed by eddy current testing.</p>
<p>Occupational health and safety requirements</p>	<p>Learners and/or employees undertaking this module should have demonstrated competencies as defined in the Metal & Engineering Industry Standards Unit No 1.2F - Apply principles of OH&S in the work environment. This would apply in the classroom, practical room or workplace.</p>