Title	**Demonstrate knowledge of electromechanical engineering principles for technicians**		
Level	**3**	**Credits**	**10**

Purpose	This unit standard covers fundamental electromechanical engineering principles and concepts for technicians working in an electrotechnology servicing or systems installation environment. People credited with this unit standard are able to demonstrate: – knowledge of lever systems and mechanical drives and their use in electromechanical systems and appliances; – fundamental knowledge of hydraulic and pneumatic energy transfer as used in electromechanical systems and appliances; – knowledge of electrical control devices, interfaces, control circuits, and control applications for appliances; – fundamental knowledge of electric motors used in appliances; – knowledge of the fundamental terms and principles of refrigeration; and – knowledge of the fundamental principles of diagnostics and the associated test equipment.

Classification	Electrical Engineering > Electrotechnology

Available grade	Achieved

Guidance Information

1 This unit standard is intended for use in electrical engineering programmes at certificate level, and has been developed for learning and assessment off-job.

2 The knowledge covered by this unit standard is expected to be at an introductory level, with the objective of introducing relevant terminology, fundamental principles, which includes the relevant mathematics for technicians in electrical engineering.

3 References

AS/NZS 3000:2007, *Electrical installations (known as the Australian/New Zealand Wiring Rules),* including Amendment 2;
AS/NZS 3760:2022, *In-service safety inspection and testing of electrical equipment and RCD's,* including Amendment 1;
AS/NZS 5762:2011, *In-service safety inspection and testing – Repaired electrical equipment*;
Electricity Act 1992;
Electricity (Safety) Regulations 2010;
and all subsequent amendments and replacements.

4 Definitions

ac – alternating current.
Appliance – any appliance that uses, or is designed or intended to use, electricity, whether or not it also uses, or is designed or intended to use, any other form of energy.
dc – direct current.
Fundamental principles – means employing the underlying factors, logic, laws and essential formulae to develop and understanding of electricity, and which forms the basis for further development and knowledge in the subject.
Industry practice – those practices that competent practitioners within the electrotechnology industry recognise as current industry best practice.
ODP – Ozone Depletion Potential.
SI – Système Internationale.

6 Conventional current flow direction (positive to negative) is implied. Candidates should be aware of the opposite direction of electron flow.

7 Assessment

a Candidates must be supplied with formulae involving more than three quantities.
b Candidates must be supplied with data tables and colour code charts.
c Use of a calculator during assessment is permitted.
d Candidates are expected to express calculated values in the relevant Système Internationale (SI) units, including multiples and sub-multiples, for example: pico (p) 10^{-12}; nano (n) 10^{-9}; micro (μ) 10^{-6}; milli (m) 10^{-3}; kilo (k) 10^{3}; mega (M) 10^{6}; Giga (G) 10^{9}; and to be able to convert between them, and, where required, convert from Imperial units into SI units.
e Performance in relation to the outcomes of this unit standard must meet the needs at an introductory level of relevant competencies 1 to 8; 15; 17 to 20; 30 to 34; 40 to 49; 51; 52 and 54 of the 55 Essential Capabilities for Registration as defined by the EWRB under the Rules of the Board;
f Electrical, radiation, and workshop or laboratory safety practices are to be observed at all times.
g All activities and evidence presented for all outcomes and performance criteria in this unit standard must be in accordance with:
  i legislation;
  ii policies and procedures;
  iii ethical codes;
  iv Standards – may include but are not limited to those listed in Schedule 2 of the Electricity (Safety) Regulations 2010;
  v applicable site, enterprise, and industry practice;
  vi where appropriate, manufacturer instructions, specifications, and data sheets.

Outcomes and performance criteria

Outcome 1

Demonstrate knowledge of lever systems and mechanical drives and their use in electromechanical systems and appliances.

Range lever systems – three orders of a simple lever, compound lever;
mechanical drives – belt and pulley drive, gear drive, direct drive;
bearings, fasteners, lubrication.

Performance criteria

1.1 Identify mechanical terms, their symbols, and their SI units of measurement.

Range speed, velocity, force, torque, energy, work, power, efficiency.

1.2 Describe lever systems and mechanical drives as used in electromechanical systems and appliances.

1.3 Describe bearings and identify functions for given types of bearings.

Range categories – radial, axial;
types – ball, roller and needle, thrust ball, thrust cylindrical roller, needle thrust, double row self-aligning, spherical, dual purpose, tapered roller dual purpose, sealed, shielded;
bearing identification codes, clearances;
evidence of two radial and two axial category bearings is required.

1.4 Describe the key requirements for the removal of bearings.

1.5 Describe lubrication requirements for bearings and describe lubrication methods and intervals.

Range types – solid, liquid, semi-solid.

1.6 Describe the main causes of bearing failure and stoppages.

Range contamination, distortion, misalignment, incorrect adjustment, incorrect lubrication, vibration when the bearing is not in motion, flow of electric current through the bearing, poor maintenance practices;
evidence of three is required.

1.7 Identify fasteners and their uses.

Range types – bolts, nuts, screws, keys, pins, retaining rings, springs, rivets, washers;
thread types, fastening sequence for ring shaped assembly.

1.8 Describe seals and reasons for their use.

1.9 Describe the removal and replacement of seals with particular reference to care required to prevent damage.

Outcome 2

Demonstrate fundamental knowledge of hydraulic and pneumatic energy transfer as used in electromechanical systems and appliances.

Performance criteria

2.1 Describe terminology used in the context of a basic hydraulic system.

Range terminology – pressure, flow, force, torque, holding pressure, linear movement, load, lift.

2.2 Describe terminology used in the context of a fundamental pneumatic system.

Range terminology – pressure, flow, orifice flow, force, torque, holding pressure, linear movement, load, lift, stroke.

2.3 Briefly explain the physical laws affecting the behaviours of a confined gas or liquid.

Range Boyles law, Charles law, Gay-Lussac's law, General Gas law, Pascals law.

2.4 Explain how force is transmitted in a fluid power system.

2.5 State the advantages and limitations of fluid power systems.

2.6 Describe examples of common devices that use fluid to control domestic appliances or equipment.

Range evidence of three devices is required.

Outcome 3

Demonstrate knowledge of electrical control devices, interfaces, control circuits, and control applications for appliances.

Performance criteria

3.1 Describe the principle of operation of control devices used in appliances, and outline two applications for each device.

Range must include – three-heat switch, energy regulator (simmerstat); may include but is not limited to – thermostat, solenoid, relay, transducer, pressure switch, limit switch, relay, switch, opto-coupler, flow switch, sensor, time switch, touch control, remote control, hall effect devices;
evidence of four control devices.

3.2 Develop and describe the operation of control circuits for given applications within an appliance.

Range evidence of eight control circuits, which must include – a three-heat switch, an energy regulator, a two-way lamp switching circuit.

Outcome 4

Demonstrate fundamental knowledge of electric motors used in appliances.

Performance criteria

4.1 Explain the fundamental operating principles of ac motors used in appliances with reference to circuit diagram, construction, and connection of stator and rotor, production of rotating magnetic field, method of starting, method of reversal of rotation, and typical applications.

Range motor types – shaded pole motor, synchronous motors, split-phase motors;
reference to mathematical formulae is not required;
circuit diagrams must be produced from memory.

4.2 Explain the fundamental operating principles of universal and dc motors used in appliances by drawing circuit diagrams.

Range circuit diagram must include – construction and connection of field windings/magnets and armature winding, brushes, method of starting, method of reversal of rotation, typical applications;
motor types – universal, series, shunt, compound, uncommutated, brushless;
reference to mathematical formulae is not required;
circuit diagrams must be produced from memory.

4.3 Explain overload protection with reference to one type of device for each of the motor types identified in 4.1 and 4.2 above.

4.4 Describe, in simple terms, methods of speed control with reference to a circuit diagram for each of the motor types identified in 4.1 and 4.2 above.

4.5 Describe the fundamental principles of inverter duty and vector duty motors with reference to advantages, limitations, and control requirements.

4.6 Describe a typical radio interference suppression circuit for one split-phase motor with reference to circuit diagram, typical component values, typical component ratings, and effect of values on touch values.

Outcome 5

Demonstrate knowledge of the fundamental terms and principles of refrigeration.

Performance criteria

5.1 Describe terminology in the context of a simple refrigeration system.

Range terminology – SI units, temperature, force and pressure, heat, work, energy and power, state of matter, latent heat, superheat, refrigerant diagrams.

5.2 Describe a refrigerant circuit with reference to its component parts and their operation.

Range evaporator, compressor, condenser, expansion process, high and low pressure sides.

5.3 Explain a fundamental refrigeration process with reference to pressure, heat removal, and a simple enthalpy diagram.

5.4 Identify common refrigerants used in consumer appliances and systems and their applications.

Range may include but is not limited to – R12, R22, R134A, R502, R407A, R410A, R600A;
evidence of three is required.

5.5 Describe requirements for handling of refrigerants.

Range PPE, certifications, disposal, ODP, green house effect, pressure, storage, transport, charging, recovery.

5.6 Describe the fundamental control devices and circuits for a simple refrigeration system.

Range devices – starting relays, thermostats, defrost timer;
circuits – starting, temperature control, light circuits, defrost circuits.

5.7 Identify the main causes of refrigeration system failure.

Range refrigeration circuit – lack of gas, punctures in pipework, contamination, blockage, moisture;
control – start relay, thermostat, light switch, lamp, defrost time, defrost element, wiring;
other – excessive ice, door seal, cracked casing, insulation, user error, integrated installation.

Outcome 6

Demonstrate knowledge of the fundamental principles of diagnostics and the associated test equipment.

Performance criteria

6.1 Identify testing equipment to suit particular applications and situations, and state the unit of measurement in each case.

Range test equipment may include but is not limited to – insulation resistance tester, multi-meter, clamp meter, inverter tester, oscilloscope, frequency counter, test probes, phase rotation meter, refrigerant leak detector, temperature test equipment, data logger; associated equipment may include but is not limited to – power supply, signal generator, test pattern generator, pulse generator; evidence of four items of test equipment is required.

6.2 Identify and describe test equipment and tools used for isolation testing, safety testing, and commissioning of appliances with reference to environment, features, and operation.

6.3 Identify and describe test equipment and tools used for diagnosing appliance faults with reference to environment, features, and operation.

6.4 Explain testing methods and procedures for isolation testing, safety testing, and commissioning of appliances.

6.5 Explain testing methods and procedures for fundamental fault location and troubleshooting of non-complex appliance faults.

Planned review date	31 December 2027

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	14 December 2017	31 December 2024
Review	2	2 March 2023	N/A

Consent and Moderation Requirements (CMR) reference	0003

This CMR can be accessed at http://www.nzqa.govt.nz/framework/search/index.do.

Comments on this unit standard

Please contact Waihanga Ara Rau Construction and Infrastructure Workforce Development Council at qualifications@waihangaararau.nz if you wish to suggest changes to the content of this unit standard.