

Title	Demonstrate knowledge of alternating current (a.c.) theory for electrical appliance servicing		
Level	4	Credits	5

Purpose	<p>This unit standard covers alternating current (a.c.) theory. It is intended for use in the training of electrical technicians and service persons.</p> <p>People credited with this unit standard are able to demonstrate knowledge of:</p> <ul style="list-style-type: none"> - principles of a.c. generation; - sinusoidal alternating waveforms of voltage and current and their relationship in a resistive circuit; - inductance and inductive reactance in a.c. circuits; - capacitance and capacitive reactance in a.c. circuits; - impedance and its application in a.c. circuits; - power factor and its application in a.c. circuits; and - power in and energy consumed by a.c. circuits.
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Classification	Electrical Engineering > Electrical Service Technicians
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Available grade	Achieved
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Guidance Information

- 1 This unit standard has been developed for learning and assessment off-job.
- 2 **Definition**
Electrical technicians and service persons – for the purposes of this unit standard means, people who hold or who are working towards electrical registration as an Electrical Service Technician, Electrical Appliance Serviceperson (endorsed to disconnect and connect), or Electrical Appliance Serviceperson.
- 3 **Range**
 - a Candidates are expected to use the Système International (SI) units, including the multiples and sub-multiples, for voltage, current, resistance, inductance, capacitance, reactance, impedance, power, and energy, and the qualitative relationships among these quantities in a.c. circuits.
 - b Use of a calculator during assessment is permitted.

Outcomes and performance criteria

Outcome 1

Demonstrate knowledge of principles of a.c. generation.

Performance criteria

- 1.1 A basic a.c. generator is sketched and its operation described.
- Range one coil in stator, rotating magnetic pole pair, flux linkage with stationary coil, induced voltage proportional to rate of change of flux.
- 1.2 The alternating voltage induced in the stationary coil by one rotation of the pole pair is sketched.
- Range voltage sinusoidal in shape, voltage zero when pole pair normal to coil, minimum rate of change of flux, voltage maximum when pole pair is in line with coil, maximum rate of change of flux.

Outcome 2

Demonstrate knowledge of sinusoidal alternating waveforms of voltage and current and their relationship in a resistive circuit.

Performance criteria

- 2.1 The sinusoidal alternating waveform for a 50 Hz voltage source is sketched.
- Range at least one cycle, sinusoidal shape, maximum value, time scale against milliseconds.
- 2.2 The root mean square (r.m.s.) value of voltage for a 50 Hz voltage source is calculated from the maximum value, and vice versa.
- Range $V_{\text{rms}} = 0.707 V_{\text{max}}$.
- 2.3 Given a 50 Hz sinusoidal alternating voltage waveform of defined r.m.s. value, the r.m.s. value of current is determined for a given value of resistance.
- 2.4 The current waveform is sketched to scale in relation to the voltage waveform.
- Range current waveform in phase with voltage waveform;
 $I_{\text{max}} = I_{\text{rms}}/0.707$.

Outcome 3

Demonstrate knowledge of inductance and inductive reactance in a.c. circuits.

Performance criteria

- 3.1 The effect of inductance in a direct current (d.c.) circuit on current switch-on and switch-off is stated.

- 3.2 Inductance is defined in terms of simple electromagnetic theory as induced electromotive force (e.m.f.) due to current flow, and its unit stated.
- Range creation of back e.m.f. by current flowing through a coil, opposition to current increase or decrease, a.c. current effects; self induction, mutual induction from other currents and coils.
- 3.3 The factors affecting inductance are described.
- Range number of turns, type of magnetic circuit.
- 3.4 Effects of inductors in a.c. circuits are described.
- Range opposition to current flow, phase shift of current waveform with respect to voltage waveform, inductive reactance and its variation with frequency.
- 3.5 Practical applications of inductors in a.c. circuits are described.
- Range current limiting, controlling, smoothing, solenoids.

Outcome 4

Demonstrate knowledge of capacitance and capacitive reactance in a.c. circuits.

Performance criteria

- 4.1 The effect of capacitance in a d.c. circuit on voltage switch-on and switch-off is stated.
- 4.2 Capacitance is defined in terms of simple electrostatic theory as induced charge due to applied voltage, and its unit stated.
- Range effect of voltage applied to capacitor, opposition to voltage increase or decrease, effect on a.c. voltage.
- 4.3 The factors affecting capacitance are described.
- Range area of capacitor plates, distance between plates, permittivity of dielectric.
- 4.4 Effects of capacitors in a.c. circuits are described.
- Range opposition to current flow, phase shift of current waveform with respect to voltage waveform, capacitive reactance and its variation with frequency, storage of charge.
- 4.5 Practical applications of capacitors in a.c. circuits are described.
- Range smoothing, reduction of arcing, radio frequency interference suppression.

- 4.6 Requirements to promptly discharge certain capacitors are described according to current regulations and standards.

Outcome 5

Demonstrate knowledge of impedance and its application in a.c. circuits.

Performance criteria

- 5.1 Impedance in an a.c. circuit is described and its units are stated.

Range resistance, inductive reactance, capacitive reactance; impedance triangle.

- 5.2 Ohm's Law relating to a.c. circuits is stated.

- 5.3 The r.m.s. value of current is obtained for given values of r.m.s. voltage, resistance, inductive reactance, and capacitive reactance.

Range application of Ohm's Law to voltage and calculated impedance.

Outcome 6

Demonstrate knowledge of power factor and its application in a.c. circuits.

Performance criteria

- 6.1 Power factor is defined.

Range determined by the angle by which the current waveform leads or lags the voltage waveform; cosine of angle of lead or lag.

- 6.2 The effect of the power factor on the power in the circuit is defined.

Range directly proportional to power factor; maximised when current waveform is in phase with voltage waveform; most a.c. loads inductive, current lags voltage, poor power factor; poor utilisation of equipment, wiring and supply plant current carrying capacities.

- 6.3 Methods of improving power factor are described.

Range connection of capacitors in parallel with circuit.

Outcome 7

Demonstrate knowledge of power in and energy consumed by a.c. circuits.

Performance criteria

- 7.1 Power in an a.c. circuit is defined and its units stated.

Range $P = V \times I \times \cos\phi$; watt (W), kilowatt (kW).

7.2 Energy consumed by an a.c. circuit is defined and its unit stated.

Range $E = P \times t$; kilowatt-hours (kWh).

This unit standard is expiring. Assessment against the standard must take place by the last date for assessment set out below.

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	28 January 2001	31 December 2013
Review	2	20 June 2006	31 December 2024
Rollover and Revision	3	20 September 2012	31 December 2024
Revision	4	15 January 2014	31 December 2024
Rollover and Revision	5	25 March 2021	31 December 2024
Review	6	2 March 2023	31 December 2024

Consent and Moderation Requirements (CMR) reference

0003

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