Title	**Demonstrate advanced knowledge of alternating current and three-phase theory**		
Level	**5**	**Credits**	**10**

Purpose	This unit standard is intended for use in the training and assessment of electricians beyond trade level. It covers alternating current (a.c.) and three-phase power theory, at a level more advanced than the requirements for the National Certificate in Electrical Engineering (Electrician for Registration) (Level 4) [Ref: 1195]. People credited with this unit standard are able to demonstrate knowledge of: – resonant alternating current circuits; – power system harmonics; – alternating current voltage dividers and phase-shift circuits; – power in three-phase balanced loads; and – three-phase unbalanced star-connected loads.

Classification	Electrical Engineering > Core Electrical

Available grade	Achieved

Guidance Information

1 Recommended skills and knowledge:
National Certificate in Electrical Engineering (Electrician for Registration) (Level 4) [Ref: 1195] or equivalent trade qualification for electricians.

2 This unit standard has been developed for learning and assessment off-job.

Outcomes and performance criteria

Outcome 1

Demonstrate knowledge of resonant alternating current circuits.

Performance criteria

1.1 Effects of changing frequency on current and impedance of resonant circuits near resonance are explained with the aid of graphs.

Range resonant circuits – series, parallel.

1.2 Resonant frequencies of reactive circuits are calculated for given data.

Range reactive circuits – series circuit, parallel circuit with negligible resistance.

1.3 Magnification factors (Q) of resonant circuits are calculated for given data.

Range series circuit voltage magnification, parallel circuit current magnification.

1.4 Bandwidth of a resonant circuit is calculated for given data.

1.5 Selectivity of resonant circuits is explained in terms of magnitude of inductor resistance.

Range high and low values of resistance, series and parallel circuits.

Outcome 2

Demonstrate knowledge of power system harmonics.

Performance criteria

2.1 Shapes of repetitive complex waveforms are explained in terms of harmonic frequencies.

Range square wave, saw-tooth wave, odd harmonics, even harmonics.

2.2 Devices introducing unwanted odd and/or even harmonics to a power system are identified, with reference to the range of significant harmonics and method of generation.

Range devices – transformers, alternators, alternating current motors, single-phase rectifiers, three-phase rectifiers, devices with non-sinusoidal loads;
evidence of five devices is required.

2.3 The result of resonance at harmonic frequency is explained in terms of harmonic current compared with fundamental current.

2.4 Use of selective resonant circuits to reduce harmonics in power systems is explained, with reference to acceptor and rejecter circuits.

Outcome 3

Demonstrate knowledge of alternating current voltage dividers and phase-shift circuits.

Performance criteria

3.1 Operation of voltage divider circuits is explained with reference to circuit and phasor diagrams.

Range voltage dividers – resistive, resistive-capacitive, resistive-inductive, centre-tapped transformer with resistive-capacitive circuit.

3.2 The effects of varying circuit parameters on the input-output phase difference are explained.

Range circuit parameters – resistance, capacitance, inductance, frequency.

Outcome 4

Demonstrate knowledge of power in three-phase balanced loads.

Performance criteria

4.1 Requirements for balance are explained in terms of line currents and power factors.

4.2 Principles of power factor improvement of three-phase systems are explained with reference to phasor diagrams or power triangles, equipment used, connection configuration, and voltage rating.

Range equipment – rotating machinery, static capacitors, harmonic filters;
configurations – delta-connected, star-connected;
voltage rating – line voltage, phase voltage.

4.3 Data for three-phase power factor correction are calculated for a given balanced load situation.

Range data – volt-amperes reactive; capacitance and voltage rating for both delta and star connections.

Outcome 5

Demonstrate knowledge of three-phase unbalanced star-connected loads.

Performance criteria

5.1 Line and neutral currents of unbalanced resistive loads are calculated for given data.

5.2 Line and neutral currents of loads having equal impedance but different power factors are calculated for given data, including unity, leading, and lagging power factors.

Planned review date	31 December 2022

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	26 February 2002	31 December 2012
Review	2	19 June 2009	N/A
Rollover and Revision	3	15 March 2012	N/A
Revision	4	15 January 2014	N/A
Rollover and Revision	5	28 January 2021	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 The Skills Organisation reviewcomments@skills.org.nz if you wish to suggest changes to the content of this unit standard.