Title	**Demonstrate and apply knowledge of a.c. principles for electronics technicians**		
Level	**4**	**Credits**	**7**

Purpose	People credited with this unit standard are able to demonstrate knowledge of: – reactive circuits and resonance; – self inductance and mutual inductance; – the nature and application of three phase sinusoidal alternating currents; – single-phase transformers; and – apply knowledge of a.c. principles.

Classification	Electronic Engineering > Core Electronics

Available grade	Achieved

Guidance Information

1 References
Electricity Act 1992;
Electricity (Safety) Regulations 2010;
Electrical Workers Registration Board (*EWRB) Rules of the Board and Teaching Guidelines* available at www.ewrb.govt.nz;
Health and Safety at Work Act 2015;
and all subsequent amendments and replacements.

2 Definitions
a.c. – alternating current.
C – capacitance.
e.m.f. – electromotive force.
Industry practice – those practices that competent practitioners within the Electronic Engineering industry recognise as current industry best practice.
kVA – kilovolt amperes.
L – inductance.
LCR – combination of inductance, capacitance, resistance.
MEN – multiple earth neutral system of electricity supply.
Q – quality factor; $Q = \frac{\omega_0}{\Delta\omega}$.
R – resistance.

3 Range
a Electrical, radiation, and workshop or laboratory safety practices are to be observed at all times.
b All measurements are to be expressed in Système Internationale (SI) units and

multipliers.

c Candidates are expected to have memorised and to be able to use the following formulae:

$L \propto \frac{N^2 \mu_0 \mu_r A}{l}$ $e_2 = M \frac{di}{dt}$; $k = \frac{M}{\sqrt{L_1 L_2}}$ $Q = \frac{\omega_0}{\Delta\omega}$.

d Use of non-programmable calculators is permitted during assessments.

e 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 EWRB Rules of the Board;
vi safe and sound practice;
vii applicable site, company, and industry practice.

Outcomes and performance criteria

Outcome 1

Demonstrate knowledge of reactive circuits and resonance.

Performance criteria

1.1 Define reactance, impedance, admittance, conductance, and Ohm's law for a.c. circuits.

1.2 Define and explain resonance for series and parallel LCR circuits.

Range includes series R and L in parallel with C.

1.3 Analyse series and parallel LCR circuits by calculation and draw phasor diagrams.

Range analysis includes – voltages and currents, reactance, impedance, Q, bandwidth.

1.4 Sketch two practical applications of reactive circuits using circuit diagrams.

Range applications may include but are not limited to – radio tuner, power supply filtering.

Outcome 2

Demonstrate knowledge of self inductance and mutual inductance.

Performance criteria

2.1 Explain the relationship between the inductance of coils and the coil parameters, including the effect of ferrite cores.

Range $L \propto \frac{N^2 \mu_0 \mu_r A}{l}$.

2.2 Determine the self-induced e.m.f. and polarity for various rates of change of current for an inductor.

2.3 Define and explain mutual induction with reference to voltage induced in the secondary coil and the coefficient of coupling.

Range series aiding, series opposing;
$e_2 = M \frac{di}{dt}$; $k = \frac{M}{\sqrt{L_1 L_2}}$.

2.4 Perform calculations involving mutual inductance, e.m.f., and the rate of change of current with respect to time to solve problems based on practical circuits.

2.5 Sketch the application of an induction coil.

Outcome 3

Demonstrate knowledge of the nature and application of three phase sinusoidal alternating currents.

Performance criteria

3.1 Sketch three-phase load configurations in accordance with industry conventions.

Range configurations – delta, 3-wire star, 4-wire star.

3.2 Draw waveform and phasor diagrams representing phase and line voltages and currents.

3.3 Give reasons for the use of three-phase systems in power generation, distribution and utilisation.

3.4 Sketch the national power generation and distribution system in terms of basic network structure from generation to consumer, voltages, delta/star transformers, and the MEN system.

3.5 Draw phasor diagrams and perform calculations for star and delta three-phase systems with balanced resistive loads.

Range calculations – line and phase voltages and currents.

Outcome 4

Demonstrate knowledge of single-phase transformers.

Performance criteria

4.1 Outline the construction of a typical transformer and define the terms.

Range terms – primary, secondary, turns ratio, kVA rating, magnetising current, core.

4.2 Use turns ratio to estimate voltage and current ratios.

4.3 Describe different types of transformer core losses and methods to reduce core losses.

Range core losses – eddy currents and hysteresis, constant; copper loss proportional to square of current;
core loss reduction methods – effect of laminations; use of ferrites, materials with narrow hysteresis loop, low resistance wire, toriods.

4.4 Explain the meaning of *load regulation* of a transformer.

4.5 Calculate the efficiency of a single-phase transformer at various load conditions and power factors and state the conditions for maximum efficiency.

Range conditions of maximum efficiency – copper losses, iron losses; calculation of load at maximum efficiency is excluded.

4.6 Explain the principles of auto-transformer construction and operation, and state the advantages and disadvantages compared to a double wound transformer.

Outcome 5

Apply knowledge of a.c. principles.

Range application must relate to at least outcomes 1, 2, and 4, and may include but is not limited to – circuit construction, experiments, fault finding, projects.

Performance criteria

5.1 Apply knowledge of a.c. principles to use instruments, tests, and experimental procedure.

5.2 Produce measurements and observations relevant to the application.

5.3 Record purpose, method, observations, measurements, and conclusions in accordance with a given format.

Planned review date	31 December 2025

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	26 July 2004	31 December 2012
Review	2	21 July 2011	31 December 2022
Review	3	24 June 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.