Title	Demonstrate and apply fundamental knowledge of a.c. principles for electronics technicians		
Level	3	Credits	7

Purpose	This unit standard covers an introduction to alternating current principles for electronics technicians. People credited with this unit standard are able to: – demonstrate fundamental knowledge of the nature of sinusoidal alternating voltages and currents; – demonstrate fundamental knowledge of frequency and the electromagnetic spectrum; – demonstrate fundamental knowledge of the nature of non-sinusoidal waveforms; – demonstrate fundamental knowledge of capacitance and capacitors; – demonstrate fundamental knowledge of inductance and inductors; – demonstrate fundamental knowledge of vector and phasor quantities; – demonstrate fundamental knowledge of reactive components in a.c. circuits; and – apply fundamental a.c. principles to a given electronics application.

Classification	Electronic Engineering > Core Electronics

Available grade	Achieved

Guidance Information

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

2   References
    Electricity Act 1992;
    Electricity (Safety) Regulations 2010;
    Health and Safety in Employment Act 1992 and associated regulations;
    and all subsequent amendments and replacements.

3   Definitions
    a.c. – alternating current.
    Fundamental knowledge – for the purposes of this unit standard means having some relevant theoretical knowledge of the subject matter with the ability to use that knowledge to interpret available information.
    CR – capacitance and resistance.

d.c. – direct current.
e.m.f. – electromotive force.
Electromagnetic spectrum – the range of frequencies of electromagnetic radiation from zero to infinity.
L – inductance.
LR – inductance and resistance.
RMS – root mean square.

4   Range
    a   All measurements are to be expressed in Système Internationale (SI) units and multipliers.
    b   Candidates are expected to have memorised and to be able to use the following formulae:

$$W = \frac{CV^2}{2}$$

$$V = L\frac{dI}{dt}$$

$$W = \frac{LI^2}{2}$$

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

Outcomes and performance criteria

Outcome 1

Demonstrate fundamental knowledge of the nature of sinusoidal alternating voltages and currents.

Performance criteria

1.1   Generation of a sinusoidal voltage is explained using a simple model of a coil rotating in a permanent magnetic field.

1.2   Sine wave instantaneous voltages are calculated at any instant, given frequency or period, and peak voltage.

1.3   Terms relating to sinusoidal waveforms are defined.

        Range   peak, peak-to-peak, average for full and half wave, RMS, form factor.

1.4   The concept of RMS and average values is explained with reference to heating effect.

1.5   Calculations are made, relating RMS, average and peak values for complete cycle, full, and half waveforms.

1.6   Voltage, current and power dissipation are calculated in resistive a.c. circuits.

Outcome 2

Demonstrate fundamental knowledge of frequency and the electromagnetic spectrum.

Performance criteria

2.1   The concepts of frequency, wave length, velocity, and amplitude of sine waves are explained, and wavelength is calculated from frequency and velocity.

2.2   The electromagnetic spectrum is described in terms of frequency bands, band characteristics, and typical usage.

Outcome 3

Demonstrate fundamental knowledge of the nature of non-sinusoidal waveforms.

Performance criteria

3.1   The terms *fundamental frequency*, *harmonics,* and *form factor* are explained in relation to square, triangular, and sawtooth waveforms.

3.2   Waveforms are sketched showing how harmonically related sinusoids sum to produce different wave shapes.

        Range   d.c. + 1st harmonic, 1st + 2nd harmonic, 1st + 3rd harmonic. Use of Fast Fourier Transform, spectrum or wave analyser, or computer simulation are permissible.

Outcome 4

Demonstrate fundamental knowledge of capacitance and capacitors.

Performance criteria

4.1   The mechanism by which a parallel plate capacitor stores charge is explained.

4.2   Calculations are performed to determine the capacitance of practical capacitors, given dimensions and materials information.

4.3   Total equivalent capacitance of series, parallel, and simple series-parallel circuits are calculated.

4.4   Voltage drop across any capacitor in a series, parallel capacitor network is calculated for d.c. steady state conditions.

4.5   The ability of capacitance to store energy, but not dissipate it, is explained, and stored energy calculated.

        Range $W = \dfrac{CV^2}{2}$.

4.6   Calculations involving the charging and discharging of a capacitor through a resistor are performed, and shape of voltage and current curves sketched.

          Range   charging capacitor via resistance from constant voltage, current and voltage at any instant of time, derivation of time constant by graphical means.

4.7   Different types of practical capacitors are compared from the point of view of construction, size, polarity, ratings, and applications.

4.8   Capacitor markings relating to capacitance value, voltage rating, and polarity are interpreted.

          Range   four different types of capacitors. Use of coding chart is permissible.

Outcome 5

Demonstrate fundamental knowledge of inductance and inductors.

Performance criteria

5.1   Inductance is defined in terms of induced e.m.f., rate of change of current, units stated.

          Range $V = L\dfrac{dI}{dt}$.

5.2   Total equivalent inductance of series, parallel, and simple series-parallel circuits are calculated.

5.3   The ability of inductance to store energy, but not dissipate it, is explained, and the stored energy calculated for a steady current.

          Range $W = \dfrac{LI^2}{2}$.

5.4   Calculations involving the charging and discharging of an inductor through a resistor are performed, and shape of voltage and current curves sketched.

          Range   inductor supplied via resistance from constant voltage; current and voltage at any instant of time; time constant determined by graphical means.

5.5   The consequences of not providing a discharge path to large inductances are explained with reference to practical examples.

          Range   typical examples – transistor driving a relay or other inductive load, d.c. motor field windings, motor car ignition.

5.6   Simple diode and resistor-diode suppression circuits are drawn using standard symbols and described in terms of their operation.

5.7   The relationship between inductance, number of turns, and permeability of core material is outlined.

> Range   core material – air, solid iron, laminated iron, ferrite.

Outcome 6

Demonstrate fundamental knowledge of vector and phasor quantities.

Performance criteria

6.1   The terms *vector* and *phasor* are defined.

> Range   vector – in terms of magnitude, direction, and point of application; phasor – in terms of magnitude and angular rotation, conventional direction of rotation defined.

6.2   Phasors are expressed in terms of rectangular and polar coordinates and conversions between the two performed.

6.3   Phasor quantities are added and resolved by calculation supported by phasor diagram sketches, to find resultant and components respectively.

Outcome 7

Demonstrate fundamental knowledge of reactive components in a.c. circuits.

Performance criteria

7.1   Reactance, impedance, and Ohms law for the a.c. circuit are defined.

7.2   Reactances and impedances are calculated and the use of impedance triangles demonstrated for simple circuits containing LR and CR.

7.3   LR and CR circuits are analysed.

> Range   for LR and CR series combinations in potential divider type of circuits –
> includes – magnitude, phase, 3db points.
> for LR combinations –
> includes – signal across the load resistor, signal across the inductor.
> for CR combinations –
> includes – signal across the load resistor, signal across the capacitor.

Outcome 8

Apply fundamental a.c. principles to a given electronics application.

Range   application must relate to the preceding outcomes, and may include but is not limited to – circuit construction, experiment, fault finding, project.

Performance criteria

8.1   The application demonstrates use of instruments, tests, and experimental procedure.

8.2   The application demonstrates analysis of measurements and observations.

8.3   Purpose, method, observations, measurements, and conclusions are recorded in accordance with a given format.

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	24 November 2003	31 December 2012
Review	2	21 July 2011	31 December 2024
Review	3	25 May 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.