

Title	Demonstrate knowledge of a.c. motors		
Level	4	Credits	7

Purpose	<p>This unit standard covers the principles, construction, calculations, and measurement of single-phase and three-phase alternating current (a.c.) motors. It is intended for use in the training of electricians and related trades.</p> <p>People credited with this unit standard are able to:</p> <ul style="list-style-type: none"> – demonstrate knowledge of single-phase motors; – demonstrate knowledge of single-phase multi-speed motors; – compare characteristics of single-phase motors; – demonstrate knowledge of three-phase induction motors; – demonstrate knowledge of the factors that affect the performance of three-phase induction motors; – perform a.c. motor calculations and verify by measurement; – reverse direction of rotation of induction motors; and – diagnose faults in electric motors.
----------------	--

Classification	Electrical Engineering > Electrical Machines
-----------------------	--

Available grade	Achieved
------------------------	----------

Explanatory notes

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

Industry practice – those practices that competent practitioners within the industry recognise as current industry best practice.

Specifications – machine specifications, maintenance instructions, or bearing manufacturers' recommendations relating to removal, cleaning, testing, and fitting of bearings and seals, and the types of lubricants to be used.
- 3 Assessment
 - a Candidates shall be supplied with formulae involving more than three quantities.
 - b Use of a calculator during assessment is permitted.
 - c Candidates are expected to express calculated values in the relevant Système International (SI) units, including multiples and sub-multiples (pico, nano, micro, milli, kilo, mega, etc) and be able to convert between them.

Outcomes and evidence requirements

Outcome 1

Demonstrate knowledge of single-phase motors.

Range motors – universal, shaded-pole, standard split-phase induction, capacitor-start, permanently-split capacitor, capacitor start and run.

Evidence requirements

1.1 Construction is described and all components are identified with the aid of a diagram or from physical examples.

Range components – casing, end shields, armature, shaft, bearings, mounting plate, commutator, field windings, field poles, centrifugal switch, capacitor, start and run windings, integrated over-temperature protection (microtherm).

1.2 Operating principles are described in terms of starting, production of rotating magnetic field, and production of torque.

1.3 Speed control methods, where achievable, are described.

1.4 Method of reversal of rotation is described with the aid of a diagram.

1.5 A typical application for each type of motor is stated with reasons for the suitability of the choice.

1.6 Types of motor enclosures are identified and the features of each stated.

Range screen protected, drip-proof, totally enclosed, flame-proof.

Outcome 2

Demonstrate knowledge of single-phase multi-speed motors.

Evidence requirements

2.1 Multi-speed motors are described with the aid of circuit diagrams with reference to principles of operation, winding connections, and speed change methods.

Range tapped-field universal motor, two-speed split-phase motor.

2.2 A typical multi-speed motor application is stated with reasons for the suitability of the choice.

Outcome 3

Compare characteristics of single-phase motors.

Range motors – universal, standard split-phase induction, capacitor-start, permanently-split capacitor, capacitor start and run, shaded pole.

Evidence requirements

3.1 Typical speed versus torque curve is sketched for each motor.

3.2 Single-phase motor properties are compared.

Range typical properties – power, speed, power to mass ratio, starting torque, starting current, power factor, efficiency, method of reversal, method of starting, starts per hour, radio frequency interference, complexity, construction cost.
Evidence of five properties is required.

3.3 Electronic speed control methods are described for each motor.

Outcome 4

Demonstrate knowledge of three-phase induction motors.

Evidence requirements

4.1 Construction of three-phase induction motors is described with the aid of diagrams and reference to components.

Range components – casing, end shields, shaft, bearings, mounting, rotor, stator, yoke, core, winding, integrated over-temperature protection (microtherm) and thermistors.

4.2 Operating principles of three-phase induction motors are explained in terms of the action of the rotating magnetic fields, the interactions of stator and rotor fluxes, and methods of starting.

4.3 Method of reversal of rotation is described with the aid of a diagram.

4.4 Speed versus torque curves are sketched, and labelled showing starting torque, running torque, rated torque, pull-out speed, and rated speed.

Range motors – squirrel cage, wound rotor with slip-rings, double cage rotor.

4.5 A typical application is stated with reasons for the suitability of the choice.

Range motors – squirrel cage, wound rotor with slip-rings, double cage rotor.

Outcome 5

Demonstrate knowledge of the factors that affect the performance of three-phase induction motors.

Evidence requirements

- 5.1 The effects of reduced supply voltage on a three-phase induction motor are described in terms of reduced torque and speed, increased current, and risk of over heating.
- 5.2 The effect of increasing load on efficiency and power factor is described in terms of increased motor current and reduced cooling.
- 5.3 The effect of the loss of one phase is stated for star and delta connected motors.
- 5.4 The effect of a reversed winding on the operation of a three-phase induction motor is stated, and two methods of rectification are explained.
- 5.5 The effect of multiple starts is explained.
- 5.6 The effects of voltage surges are explained.

Range effects may include but are not limited to – harmonics, lightning strikes, multi-control systems.

Outcome 6

Perform a.c. motor calculations and verify by measurement.

Range calculations – run current, start current, synchronous speed, rotor speed, slip speed, input power, output power, efficiency;
motors – single-phase induction, capacitor-start split-phase, three-phase cage, three-phase slip-ring.

Evidence requirements

- 6.1 Calculations are made in accordance with industry practice.
- 6.2 Values are measured in accordance with industry practice.
- 6.3 Measured and calculated values are compared and variations explained in terms of load variations, instrument tolerance, and measurement error.

Outcome 7

Reverse direction of rotation of induction motors.

Range single-phase, three-phase.

Evidence requirements

- 7.1 Motor is connected to mains and the direction of rotation is reversed by means of a reversing switch.
- 7.2 Motor is connected to mains and the direction of rotation is reversed by means of contactors.

Outcome 8

Diagnose faults in electric motors.

Range motor types – single-phase, three-phase.
Evidence of two types of fault on each motor is required.

Evidence requirements

- 8.1 Fault diagnosis includes verification of motor performance against specifications or records of previous performance, in accordance with industry practice.

Range dynamometer or in situ connected-load tests, power factor, line current, speed, output.
- 8.2 Visible and audible defects are identified.

Range defects may include but are not limited to – excessive sparking during operation; signs of tracking; overheating indicators such as discolouration, burning, melting, or burnt insulation smell; excessive vibration and noise; noisy, sloppy, or worn bearings; worn, loose, or damaged accessories; damage to casing, foot-plate, end plates, terminal box and cover, fan and fan cover.
- 8.3 Fault-finding demonstrates a logical technique for analysing symptoms, and making electrical measurements where necessary, to locate fault and/or faulty components.
- 8.4 Assessment of viability of repair takes into account availability of parts, cost, time, and supervisor’s instructions.
- 8.5 Results are documented in accordance with industry practice.

Replacement information	This unit standard has been replaced by unit standard 29443.
--------------------------------	--

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	10 February 1999	31 December 2013
Review	2	26 May 2005	31 December 2013
Review	3	22 August 2008	31 December 2021
Rollover and Revision	4	15 March 2012	31 December 2021
Revision	5	15 January 2014	31 December 2021
Review	6	21 July 2016	31 December 2021

Consent and Moderation Requirements (CMR) reference

0003

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

Please note

Providers must be granted consent to assess against standards (accredited) by NZQA, before they can report credits from assessment against unit standards or deliver courses of study leading to that assessment.

Industry Training Organisations must be granted consent to assess against standards by NZQA before they can register credits from assessment against unit standards.

Providers and Industry Training Organisations, which have been granted consent and which are assessing against unit standards must engage with the moderation system that applies to those standards.

Requirements for consent to assess and an outline of the moderation system that applies to this standard are outlined in the Consent and Moderation Requirements (CMR). The CMR also includes useful information about special requirements for organisations wishing to develop education and training programmes, such as minimum qualifications for tutors and assessors, and special resource requirements.

This unit standard is expiring