Title	**Demonstrate advanced knowledge of electrical machines**		
Level	**5**	**Credits**	**10**

Purpose	This unit standard is intended for use in the training and assessment of electricians beyond trade level. It covers theory of electrical machines, 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: – the construction and operation of direct current generators; – the construction and operation of direct current motors; – three-phase alternators; – synchronous motors; – non-standard three-phase induction motors; and – electrical braking of a.c. motors

Classification	Electrical Engineering > Electrical Machines

Available grade	Achieved

Guidance Information

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

2 Definitions
a.c. – alternating current.
d.c. – direct current.

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

Outcomes and performance criteria

Outcome 1

Demonstrate knowledge of the construction and operation of direct current generators.

Performance criteria

1.1 Commutation in a d.c. generator is explained in terms of reactance voltage and under-commutation.

1.2 Armature reaction in a d.c. generator is explained in terms of variation of load and shift of magnetic neutral axis.

1.3 Use of interpoles in d.c. generators is explained in terms of the polarity of interpoles and improved commutation.

1.4 Reasons for excitation failure are explained.

Range at least five reasons, relating to any of – residual magnetism, critical field resistance, direction of rotation, speed, load, field connections, brush contact and position.

Outcome 2

Demonstrate knowledge of the construction and operation of direct current motors.

Performance criteria

2.1 Commutation in a d.c. motor is explained with reference to ideal commutation.

Range under commutation, over commutation.

2.2 Armature reaction in a d.c. motor is explained in terms of distortion of main field flux.

2.3 Use of interpoles in d.c. motors is explained with reference to the polarity of interpoles and improvement in commutation.

2.4 Speed control systems of large d.c. motors are described.

Range Ward-Leonard system, thyristor control, field current control, closed-loop speed control.

2.5 Electrical braking methods for d.c. motors are described with reference to operation, features, and applications.

Range methods – dynamic braking, regenerative braking.

Outcome 3

Demonstrate knowledge of three-phase alternators.

Performance criteria

3.1 Construction of a standard alternator is described with reference to rotor and stator windings, and slip rings and brushes.

3.2 Methods of alternator excitation are described with reference to circuit diagrams.

Range methods – d.c. generator exciter, alternator with rectifier exciter.

3.3 Operation and control of a brushless alternator is described with reference to a circuit diagram.

3.4 Regulation of an alternator is calculated from no-load and full load voltages.

Range regulation – per unit value, percentage value.

Outcome 4

Demonstrate knowledge of synchronous motors.

Performance criteria

4.1 Principles of operation and features of synchronous motors are described.

Range features – constant speed, reversion to an alternator.

4.2 Methods of starting synchronous motors are described, with reference to the advantages of each.

Range starting methods – pony motor, cage winding in rotor, rotor construction with damping winding, slip ring induction motor start.

4.3 Effects of load on a synchronous motor are explained using phasor diagrams.

Range no-load to full load.

4.4 Effects of varying excitation of a lightly loaded synchronous motor are explained using phasor diagrams.

Range effect – lagging power factor, leading power factor.

4.5 Application of a synchronous motor as a synchronous capacitor to improve power factor is explained.

Outcome 5

Demonstrate knowledge of non-standard three-phase induction motors.

Range non-standard – high-slip, double-cage, pole-change, slip ring.

Performance criteria

5.1 Features of a high-slip induction motor are explained with reference to construction, characteristics, and typical applications.

5.2 Features of a double-cage induction motor are explained with reference to construction, characteristics, and typical applications.

5.3 Winding connections of a pole-change induction motor are described for high-speed, low-speed, constant torque, and constant power.

Range two-pole series, two-pole parallel, four-pole series, four-pole parallel.

Outcome 6

Demonstrate knowledge of electrical braking of a.c. motors.

Performance criteria

6.1 Methods of electrical braking of a.c. motors are explained and their advantages and disadvantages compared.

Range methods – braking by plugging, braking by d.c. injection, regenerative braking.

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	26 February 2002	31 December 2013
Review	2	19 June 2009	31 December 2024
Rollover and Revision	3	15 March 2012	31 December 2024
Revision	4	15 January 2014	31 December 2024
Review	5	22 August 2019	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.