Title	**Demonstrate knowledge of electrical machines in power engineering**		
Level	**5**	**Credits**	**15**

Purpose	People credited with this unit standard are able to: • demonstrate knowledge of the theory and application of single and three phase power transformers • demonstrate knowledge of d.c. motor and generator operation, • demonstrate knowledge of induction motor theory, • demonstrate knowledge, and apply the theory of synchronous machines, and • describe the requirements and characteristics of selected motors or generators in the electricity supply industry. This standard provides electricity supply industry power technicians with the fundamental knowledge of power protection and control network theory, and hardware.

Classification	Electricity Supply > Electricity Supply - Power System Maintenance

Available grade	Achieved

Guidance Information

1 Definitions
a.c. – alternating current.
d.c. – direct current.
KVA – kilovolt ampere.
VFD – variable frequency drive.
VSD – variable speed drive.

2 It is recommended that Unit 29732, *Demonstrate knowledge of electrical principles in power engineering;* or equivalent knowledge and skills is demonstrated prior to assessment of this standard.

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Outcomes and performance criteria

Outcome 1

Demonstrate knowledge of the theory and application of single and three phase power transformers.

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Performance criteria

1.1 Terminology used with power transformers is defined and explained.

Range primary, secondary, turns ratio, KVA rating, magnetising current, equivalent circuit, step up, step down, isolating, autotransformer, no load, full load.

1.2 Transformer turns ratio is explained and used to estimate voltage and current ratios for practical transformers.

1.3 Construction of low to medium power practical transformers is described.

Range single phase, three phase, autotransformer.

1.4 Causes of core losses are identified and methods to reduce these are described.

Range copper and iron core losses.

1.5 The efficiency of a single phase transformer is calculated at various load conditions and power factors.

Range 125%, 100%, 75% full load.

1.6 Load regulation of a transformer is explained and demonstrated.

1.7 Vector group configuration of three phase transformers is explained.

Outcome 2

Demonstrate knowledge of d.c. motor and generator operation.

Performance criteria

2.1 Concepts and operating principles of d.c. motors are explained.

Range single loop conductor in a constant two-pole magnetic field; direction of rotation; factors influencing torque; shunt wound motor; series wound motor; cumulatively compounded motor; output calculations.

2.2 Concepts and operating principles of d.c. generators are explained.

Range single loop conductor in a constant two-pole magnetic field, direction of rotation; the shunt generator; output calculations.

2.3 Methods of speed, torque control and voltage output of d.c. machines are explained and demonstrated.

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Outcome 3

Demonstrate knowledge of induction motor theory.

Performance criteria

3.1 The construction of a single and three phase induction motor is explained.

Range includes but not limited to – squirrel cage, wound rotor.

3.2 Operating principles and control of single-phase and three-phase induction motors are explained.

Range electrical and mechanical power, torque, slip, efficiency, power factor; speed control using pole switching,

3.3 Analysis and prediction of motor performance using transformer equivalent circuit model is investigated.

3.4 Induction motor starting and protection methods are described and compared.

Range motor control using traditional, soft and solid state starters.

3.5 Miscellaneous a.c. motors for given applications are selected and operational reasoning is described.

Range single-phase induction motors, split-phase, capacitor start, capacitor run, shaded pole and small synchronous; universal motor, stepper motor, servo.

3.6 Methods of speed and torque control is explained and demonstrated for single and three phase squirrel cage machines.

Range may include – soft start, VSD, VFD, vector control, single phase speed control.

3.7 Use of an induction machine as an a.c. generator (wind or hydro) running on the distribution grid or stand alone is explained.

Outcome 4

Demonstrate knowledge of, and apply the theory of synchronous machines.

Performance criteria

4.1 The constructional and operational characteristics of three-phase synchronous machines are described.

4.2 Synchronous impedance, stability, torque angle, excitation, power factor and operational charts are explained.

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4.3 The synchronous impedance and expected output voltage of a three-phase synchronous machine is determined by calculation, using the parameters from the equivalent circuit.

4.4 The operational characteristics of synchronous machines connected to infinite bus and standalone as a motor or generator is explained and demonstrated.

Range synchronisation with an infinite bus, motor starting methods, power factor control on infinite grid or standalone.

Outcome 5

Describe the requirements and characteristics of selected motors or generators in the electricity supply industry.

Range may include – pumps, compressors, fans, high inertia loads, conveyors, winding machines, hydro generation, wind generation, thermal generation, gas turbine generation.

Performance criteria

5.1 The factors that must be considered when selecting a motor or generator for given applications are described.

Range includes but is not limited to – load type, electrical supply, starting method, application speed and torque requirements on starting and run.

5.2 Motors or generators are selected for given applications and the selection justified.

Range may include – pumps, compressors, fans, high inertia loads, conveyors, winding machines, hydro generation, wind generation, thermal generation, gas turbine generation.
evidence for three applications.

5.3 The use of mechanical gearboxes, toothed or V belt pulley systems to control speed and torque is explained.

This unit standard is expiring

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	20 July 2017	31 December 2024
Review	2	2 March 2023	31 December 2024

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Consent and Moderation Requirements (CMR) reference	0120

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

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