

<b>Title</b>	<b>Demonstrate and apply knowledge of capacitance, inductance, power factor, and power factor correction</b>		
<b>Level</b>	<b>3</b>	<b>Credits</b>	<b>7</b>

<b>Purpose</b>	<p>This unit standard covers an introduction to alternating current principles for electrical workers.</p> <p>People credited with this unit standard are able to:</p> <ul style="list-style-type: none"> <li>– demonstrate knowledge of capacitors;</li> <li>– demonstrate fundamental knowledge of inductance and inductors;</li> <li>– demonstrate fundamental knowledge of vector and phasor quantities;</li> <li>– demonstrate fundamental knowledge of reactive components and power in a.c. circuits;</li> <li>– demonstrate knowledge of inductance and capacitance in a.c. circuits;</li> <li>– demonstrate knowledge of electrical power, energy, and cost of consumption in single phase circuits;</li> <li>– demonstrate knowledge of a.c. power factor; and</li> <li>– calculate capacitance required to correct lagging power factor.</li> </ul>
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<b>Classification</b>	Electrical Engineering > Core Electrical
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<b>Available grade</b>	Achieved
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### Explanatory notes

- 1 This unit standard has been developed for learning and assessment off-job;
- 2 This unit standard and unit standard 25070 meet the assessment requirements of ERAC EPC 3.  
This unit standard and unit standard 29475 meet the assessment requirements of ERAC EPC 6.  
This unit standard and unit standards 25071, 25072, 29470, and 29477 meet the assessment requirements of ERAC CEPC 8.  
This unit standard meets the assessment requirements of ERAC EPC 11.  
This unit standard and unit standards 29422, 29472, and 29481 meet the assessment requirements of ERAC CEPC 53.
- 3 Definitions  
*a.c.* – alternating current.  
*CEPC* – Critical Essential Performance Capability.  
*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.

*EPC* – Essential Performance Capability.

*ERAC* – Electrical Regulatory Authorities Council.

*Fundamental knowledge* – means having some relevant theoretical knowledge of the subject matter with the ability to use that knowledge to interpret available information.

*I* – current.

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

*L* – inductance.

*LR* – inductance and resistance.

*RMS* – root mean square.

*Safe and sound practice* – as it relates to the installation of electrical equipment is defined in AS/NZS 3000:2007, *Electrical Installations (known as the Australian/New Zealand Wiring Rules)*.

*t* – time.

*V* – voltage.

*VAR* – volt-ampere reactive.

#### 4 Range

- a Candidates to 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.
- d Candidates may refer to current legislation and Standards during assessment.
- e Demonstration of safe working practices and installation in accordance with *safe and sound practice* are essential components of assessment of this unit standard.
- f All activities and evidence presented for all outcomes and evidence requirements 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 applicable site, enterprise, and industry practice; and,
  - vi where appropriate, manufacturers' instructions, specifications, and data sheets.

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## Outcomes and evidence requirements

### Outcome 1

Demonstrate knowledge of capacitors.

### Evidence requirements

- 1.1 Describe the construction of capacitors used in electrical systems.
- 1.2 Define capacitance in terms of voltage and charge, and state symbol and units.

- 1.3 Identify factors that influence the value of capacitance, the working voltage, and the effect of connecting capacitors in series and parallel.
- 1.4 Identify capacitance and voltage rating from capacitor markings.
- 1.5 State the regulatory requirements relating to capacitors used for radio and television interference suppression and give reasons.
- 1.6 State the safety precautions to be observed to prevent electric shock from charged capacitors.
- 1.7 Describe the practical application of capacitors in a.c. power circuits in terms of power factor correction, reducing of arcing, and voltage control.

## Outcome 2

Demonstrate fundamental knowledge of inductance and inductors.

### Evidence requirements

- 2.1 Describe the constructional features of inductors used in electrical systems.
- 2.2 Describe the factors that influence the inductance values.
- 2.3 Describe characteristics and effects of inductors in a.c. circuits.  
  
Range phase relationship between supply current and voltage, inductive reactance.
- 2.4 Describe practical applications of inductors in a.c. power circuits.  
  
Range current limiting, smoothing, power factor correction, voltage control.
- 2.5 Describe symbols and units used for inductors.
- 2.6 Explain the consequences of not providing a discharge path to large inductances and give practical examples.

## Outcome 3

Demonstrate fundamental knowledge of vector and phasor quantities.

### Evidence requirements

- 3.1 Define the terms *vector* and *phasor* and outline the conventional direction of rotation.  
  
Range vector – in terms of magnitude, direction, and point of application;  
phasor – in terms of magnitude and angular rotation.
- 3.2 Add phasor quantities and resolve using calculations supported by phasor

diagram sketches to find resultant and components respectively.

#### Outcome 4

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

##### Evidence requirements

- 4.1 Define reactance, impedance, and Ohms law for the a.c. circuit.
- 4.2 Calculate reactances for simple LR and CR circuits.
- 4.3 Demonstrate the use of impedance triangles for simple LR and CR circuits.
- 4.4 Calculate RMS, average, and peak values for a complete cycle, full, and half waveforms.
- 4.5 Calculate voltage, current, and power dissipation in resistive a.c. circuits.
- 4.6 Explain the terms *fundamental frequency*, *harmonics*, and *form factor* in relation to square, triangular, and sawtooth waveforms.

#### Outcome 5

Demonstrate knowledge of inductance and capacitance in a.c. circuits.

##### Evidence requirements

- 5.1 Define impedance in terms of the combined effects of resistance and reactance in an a.c. circuit.
- 5.2 Carry out calculations involving inductance, capacitance, and resistance combinations in series.  
  
Range impedance, supply current, voltage drops across individual components, phase angle, power factor.

#### Outcome 6

Demonstrate knowledge of electrical power, energy, and cost of consumption in single phase circuits.

##### Evidence requirements

- 6.1 Define electrical power in terms of voltage, current, and resistance and state the unit and symbols.
- 6.2 Define electrical energy in terms of power and time taken and state the unit and symbols.
- 6.3 Calculate electrical energy consumption costs from given data for simple domestic installations.

Range kilowatt-hours, cost in dollars.

6.4 Describe the relationship between energy, power, voltage, current, and time, in terms of the formulae  $W = Pt = VIt$ .

6.5 Identify units of energy and power and convert between them.

Range units of power – watts (W), kilowatts (kW), horsepower (hp);  
units of energy – joules (J), kilowatt-hours (kWh);  
conversions – 1 hp = 746 watts, 1kWh = 3.6MJ.

### Outcome 7

Demonstrate knowledge of a.c. power factor.

#### Evidence requirements

7.1 Define the term *power factor* with reference to impedance and power triangles.

7.2 Explain the meanings of leading, lagging, and unity power factors with reference to the loads producing them and how they may be improved.

7.3 State the effects of a low lagging power factor in a power supply system.

Range low active power for VA input, increased supply current for a given active power, increased capacity of supply equipment required.

7.4 Draw phasor diagrams to show power factor improvement of a lagging circuit. The diagrams are to show the uncorrected circuit, the addition of a capacitive component, and the resultant corrected circuit.

7.5 Explain the practical limitations to improving power factor beyond 0.95 in terms of value, the physical size of corrective capacitors, and cost.

### Outcome 8

Calculate capacitance required to correct lagging power factor.

#### Evidence requirements

8.1 Use charts and table to calculate the required corrective capacitive VAR for given load conditions.

8.2 Use charts and tables to determine the reduction in supply current as a result of applying capacitive power factor correction.

<b>Planned review date</b>	31 December 2019
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**Status information and last date for assessment for superseded versions**

Process	Version	Date	Last Date for Assessment
Registration	1	21 July 2016	N/A
Revision	2	16 March 2017	N/A

<b>Consent and Moderation Requirements (CMR) reference</b>	0003
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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 (CMRs). 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.

**Comments on this unit standard**

Please contact The Skills Organisation at [reviewcomments@skills.org.nz](mailto:reviewcomments@skills.org.nz) if you wish to suggest changes to the content of this unit standard.