| Title | Demonstrate and apply knowledge of capacitance, inductance, power factor, and power factor correction | | |
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| Level | 3 | Credits | 7 |

| Purpose | This unit standard covers an introduction to alternating current principles for electrical workers. People credited with this unit standard are able to: <br>– demonstrate knowledge of capacitors; <br>– demonstrate fundamental knowledge of inductance and inductors; <br>– demonstrate fundamental knowledge of vector and phasor quantities; <br>– demonstrate fundamental knowledge of reactive components and power in a.c. circuits; <br>– demonstrate knowledge of inductance and capacitance in a.c. circuits; <br>– demonstrate knowledge of electrical power, energy, and cost of consumption in single phase circuits; <br>– demonstrate knowledge of a.c. power factor; and <br>– calculate capacitance required to correct lagging power factor. |
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| Classification | Electrical Engineering > Core Electrical |
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| Available grade | Achieved |
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### Guidance Information

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 performance criteria 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.

## Outcomes and performance criteria

### Outcome 1

Demonstrate knowledge of capacitors.

### Performance criteria

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.

**Performance criteria**

2.1     Describe he 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.

**Performance criteria**

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.

**Performance criteria**

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.

**Performance criteria**

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.

**Performance criteria**

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.

## Performance criteria

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.

## Performance criteria

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.

**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 | 21 July 2016 | 31 December 2027 |
| Revision | 2 | 16 March 2017 | 31 December 2027 |
| Review | 3 | 25 May 2023 | 31 December 2027 |

| **Consent and Moderation Requirements (CMR) reference** | 0003 |
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This CMR can be accessed at http://www.nzqa.govt.nz/framework/search/index.do.