



## REGISTERED NATIONAL STANDARD

### UNIT OF COMPETENCY

<b>Title:</b>	Develop knowledge on Electrical Principles <sup>1</sup>				
<b>TQF Level:</b>	4	<b>Credits:</b>	10	<b>Version:</b>	1
<b>National standard code:</b>	NS117-04				
<b>Associated qualification (and code):</b>	National Certificate in Sustainable Energy (Solar) Level 4				
<b>Approval date:</b>	10 <sup>th</sup> June 2026	<b>Review date:</b>	10 <sup>th</sup> June 2031		
<b>Purpose:</b>	<p>This unit standard involves imparting knowledge on electrical principles, in particular:</p> <ul style="list-style-type: none"> <li>• Explain electrical concepts including ohm's law, voltage, current, power and energy and their units</li> <li>• Understanding ac and dc supply systems</li> <li>• Understand ac circuits and resonance</li> <li>• Explain single phase and three phase systems</li> <li>• Define power factor and explain power factor correction</li> <li>• Understand transformers including distribution transformers</li> </ul>				

<sup>1</sup> Note, due to safety issues inherent in working with electricity, all training and assessment activities must be in accordance with local industry and regulatory requirements.

<b>Learning Outcome 1 (LO1)</b>	Understand electrical concepts
<b>Performance standards</b>	<p>1.1 Explain ohms law, voltage, current, resistance, power and energy in electrical circuits;</p> <p>1.2 Use energy units, joules and kilowatts;</p> <p>1.3 Calculate the resistance of cables and resistivity;</p> <p>1.4 Calculate solution of simple resistive networks involving resistors in series, in parallel and combined arrangement;</p> <p>1.5 Explain resistance, inductance and capacitance in a conductor;</p> <p>1.6 Explain magnetic field about a conductor, magnetic field about a solenoid, effect of iron core, concept of magnetic flux and flux density, units.</p>
<b>Learning Outcome 2 (LO2)</b>	Understand sources of electrical supply
<b>Performance Standards</b>	<p>2.1 Compare a.c. and d.c. supply systems and also relate to solar PV systems;</p> <p>2.2 Explain theory of action and characteristics of primary and secondary cells;</p> <p>2.3 Outline the applications for commonly used types of primary and secondary cells;</p> <p>2.4 Explain Ampere hour rating for batteries;</p> <p>2.5 Explain principle of rotating electromagnetic generators to give d.c. and sinusoidal a.c. supplies, draw the equivalent circuit for a source of supply;</p> <p>2.6 Calculate prospective short circuit current and battery charging for supply voltage regulation;</p> <p>2.7 Interpret a.c. supplies frequency, periodic time, peak, RMS and average values.</p>
<b>Learning Outcome 3 (LO3)</b>	Analyse <i>alternating current</i> (AC) circuits
<b>Performance Standards</b>	<p>3.1 Calculate current, voltage and power across components in RL, RC, LC, RLC circuits, series and parallel;</p> <p>3.2 Illustrate construction of phasor diagrams;</p> <p>3.3 Explain application of resonance power engineering;</p> <p>3.4 Interpret a.c. parallel circuit solution by phasor analysis or by calculation.</p>
<b>Learning Outcome 4 (LO4)</b>	Analyse three phase supply
<b>Performance standards</b>	<p>4.1 Explain advantages of three phase over two-phase and one-phase systems;</p> <p>4.2 Explain phase displacement in three-phase supply;</p>

	<p>4.3 Show power circuits, three-phase configuration, star and delta connections of loads;</p> <p>4.4 Show connection of single-phase line and phase voltage loads to a three or four wire system;</p> <p>4.5 Indicate current distribution in three phase systems phasor solution;</p> <p>4.6 Describe power(kW) and apparent power (kVA) in a three-phase system;</p> <p>4.7 State effects of typical faults in three phase systems.</p>
<b>Learning Outcome 5 (LO5)</b>	Understand <b>power</b> and <b>power factor</b> in <i>alternating current</i> (AC) circuits
<b>Performance standards</b>	<p>5.1 Calculate power losses, true power (P), apparent power (S) and reactive power (Q);</p> <p>5.2 Define power factor, effects of low power factor and causes;</p> <p>5.3 Determine power factor and explain power factor correction;</p> <p>5.4 Determine of power factor correction unit and sizing;</p> <p>5.5 Determine the power in three phase circuit;</p> <p>5.6 Identify factors affecting position of power factor correction;</p> <p>5.7 Perform the units' calculations relating to power factor correction in single phase circuits;</p> <p>5.8 State reasons for rating plant in kVA;</p> <p>5.9 Select the size of capacitor bank for power factor correction.</p>
<b>Learning Outcome 6 (LO6)</b>	Demonstrate distribution transformers
<b>Performance standards</b>	<p>6.1 Identify types of distribution transformers;</p> <p>6.2 Explain regulation and transformer efficiencies;</p> <p>6.3 Demonstrate terminals or leak markings, transformer polarity;</p> <p>6.4 Show distribution transformer loading guides;</p> <p>6.5 Explain equivalent circuits of a transformer;</p> <p>6.6 Show single phase transformer connections;</p> <p>6.7 Show three phase connections;</p> <p>6.8 Explain the auto transformers.</p>
<b>Pre-requisites</b>	N/A
<b>Co-requisites</b>	N/A

<p><b>Underpinning skill and knowledge</b></p>	<p>The following knowledge and skills underpin this unit standard:</p> <p><b>Knowledge:</b></p> <ol style="list-style-type: none"> <li>1. Knowledge of ohm's law</li> <li>2. Knowledge of power and energy and their units</li> <li>3. Knowledge of electro-magnetism</li> </ol> <p><b>Skills</b></p> <ol style="list-style-type: none"> <li>4. Safe working principles and equipment handling skills</li> <li>5. Basic calculation skills</li> <li>6. Basic measurement skills</li> </ol>
<p><b>Assessment requirements</b></p>	<p><b><u>Methods of assessment:</u></b></p> <p>A range of assessment methods should be used to assess students' knowledge and application of skills. These shall include but are not restricted to the following:</p> <ol style="list-style-type: none"> <li>a) Direct observation of students performing certain tasks stated under context of assessment;</li> <li>b) Oral questions to test relevant skills and knowledge during observation (e.g., Interviews)</li> <li>c) Written assessment such as: <ol style="list-style-type: none"> <li>i) Tutorial exercises on important topics in preparation for the final examination</li> <li>ii) Final examination</li> </ol> </li> <li>d) Practical assessment: Assessment of power measurements in single and three phase systems, identifying resistors, capacitors and inductors, identifying transformer parts, etc.</li> </ol> <p><i>The student needs to be competent in the final exam and the practical assessment to be classified as "competent" overall for the unit.</i></p>
<p><b>Moderation arrangements</b></p>	<ol style="list-style-type: none"> <li>1. Training providers must have their own moderation system approved by TNQAB before accreditation is granted: <ol style="list-style-type: none"> <li>a) Relevant internal moderation processes are documented</li> <li>b) Assessment is planned for each unit, and moderation processes are integrated into such plan</li> </ol> </li> <li>2. External moderation is conducted by the National Qualifications unit of TNQAB for all unit components of national qualifications:</li> </ol>

	<p>a) Samples of assessed activities are submitted for moderation;</p> <p>b) Moderation (external) forms are available on request from the National Qualifications unit of TNQAB.</p>
<p><b>Resource requirements</b></p>	<p>1. Access to essential electrical measuring &amp; testing equipment:</p> <ul style="list-style-type: none"> <li>• digital multimeters</li> <li>• oscilloscopes</li> <li>• clamp meter</li> <li>• LCR meter</li> <li>• wattmeter</li> <li>• energy meter</li> <li>• Transformer</li> </ul> <p>2. Worker's tools</p> <ul style="list-style-type: none"> <li>• Insulated screw-drivers</li> <li>• Insulated pliers</li> </ul> <p>3. Testing equipment</p> <ul style="list-style-type: none"> <li>• Multimeter</li> <li>• Clamp meter</li> </ul> <p>4. Personal Protection Equipment</p> <ul style="list-style-type: none"> <li>• Safety shoes</li> <li>• Apron</li> </ul> <p>Recommended text:</p> <p>Jenneson, Harper, Moore, Dand, Jones &amp; Scott, Electrical Principles for the Electrical Trades, 8th Edition</p>
<p><b>Requirements to complete this unit</b></p>	<p>To demonstrate competence, the person studying this unit is:</p> <ol style="list-style-type: none"> <li>1. Required to demonstrate all LOs to the expected standards of performance;</li> <li>2. Required to attain an <i>Achieved</i> Grade (Competent) to fulfil the requirements of the Unit Standard. The person is required to be competent in the final exam and practical assessment to attain a pass grade in this unit;</li> <li>3. Eligible to three (3) attempts in the final exam and practical assessment to achieve the required competency within 14 days of the first attempt.</li> </ol> <p>Failure to achieve the required competency level after three (3) attempts of the exam or specific part of the assessment will require the person studying this Unit to re-enrol for the same Unit.</p>

**Important notes and definitions**

**Notes:**

1. All activities associated with this unit standard must comply with the requirements of national codes of practice, regulations and legislation for workplace health, safety, and environmental protection and any subsequent amendments.
2. Assessors must comply with Tonga national assessment and moderation requirements.
3. The delivery of all units of competencies must be in sequential order and ensure that the pre-requisites requirements are met.

**Definitions:**

1. *a.c* stands for Alternating Current in electricity. The type of electrical current that periodically reverses direction, which is used to deliver power to homes and businesses.
2. *Apparent power* refers the total power flowing in an alternating current (AC) electrical system.
3. *Capacitance* refers to the ability of a system to store an electric charge.
4. *Capacitor* is an electronic component that stores electrical energy in an electric field.
5. *Capacitor bank* is a group of identical individual capacitors connected together in series or parallel.
6. *Current* refers to the flow of electric charge through a conductor typically measured in amperes.
7. *d.c* stands for Direct Current in electricity. This electrical current flows steadily in one direction, commonly found in batteries, solar cells and electronic devices.
8. *Electrical circuit* is a continuous closed path or loop that allows electricity (electric current) to flow from a power source to perform a task.
9. *Electrical Energy* refers to the product of power (kW) and time(s).
10. *Electrical Power* (or Power) refers to the rate, per unit time, at which electrical energy is transferred by an electric circuit. In other words, it is the rate at which the work is being done in an electrical circuit.

11. **Flux density** is the measure of how concentrated a physical 'flow' such as electricity is as it passes through a specific area.
12. **Inductance** is the property of an electrical conductor to resist changes in the current flowing through it by generating a magnetic field.
13. **kVA** stands for kilovolt-ampere. It is a unit used to measure the *apparent power* in an electrical system.
14. **LC** refers to Inductor-Capacitor circuit. It combines an inductor (*L*) and a capacitor (*C*) to store and transfer electrical energy.
15. **Magnetic flux** is a measure of the total magnetic field passing through a given surface area.
16. **Ohm's law** is a fundamental principle in physics and electronics that defines the relationship between voltage, current and resistance in an electrical circuit.
17. **Phasor diagrams** is a graphical tool used to visualize alternating current (AC) circuits by representing oscillating voltages and currents as rotating arrows (vectors) on a complex plane.
18. **Power factor** is a measure of how efficiently the electrical equipment converts the power drawn from the grid into useful work.
19. **RC** refers to a Resistor-Capacitor circuit. It is a fundamental electronic circuit composed of at least one resistor (*R*) and one capacitor (*C*).
20. **Resistance** is the opposition to electrical current flow.
21. **RL** refers to Resistor-Inductor circuit. It is an electrical circuit that combines the resistor (*R*) and an inductor (*L*) connected in either a series or parallel configuration.
22. **RLC** refers to an electrical circuit made of three core components: Resistor, Inductor and Capacitor.
23. **Sinusoidal a.c** is electricity that continuously reverses direction and fluctuates in magnitude, tracing a smooth, wave-like pattern known as a sine wave.
24. **Transformer polarity** refers to the instantaneous direction of the voltage in the primary winding.

	25. <i>Voltage</i> is the ' <i>electrical pressure</i> ' or force that pushes electric charges (current) through a conducting loop.
<b>Public comments on unit</b>	Please contact TNQAB National Qualifications Unit (email <a href="mailto:EnquireNQ@tnqab.to">EnquireNQ@tnqab.to</a> or Telephone 28136) if you like to discuss or suggest changes to the details of this unit.