1. Module details

Module name

Applied Electricity 5

Suggested structured learning time

A learner possessing the prerequisite skills and knowledge should achieve the module purpose in 36 to 40 hours.

Module code

NUE057

Discipline code

0703120

2. Module purpose

This module helps prepare Learners for further learning in the power applications of electricity. It provides Learners with knowledge of the consequences of low power factor and how this is dealt with in practice.

Learners will gain an understanding of three phase systems and circuits and the relationship between line and phase values. They will develop skills in solving system problems involving balanced and unbalanced systems. Also, the module introduces the problems associated with harmonics in a.c. systems.

3. Learning pathway

Intended use in the structured learning program

This module is intended to supplement exposure to electrical installation work. In particular it applies to the installation, maintenance, testing, commissioning and fault finding of electrical installation and equipment.

Therefore before undertaking this module a student should have an understanding and experience of electrical installations and how the fundamental principles for safety apply.

Recommended prerequisites

For the most effective learning this module should be undertaken only after modules NUE055 Applied Electricity 3 and NUE056 Applied Electricity 4 have been completed.

4. Relationship to competency standards

This module provides part of the underpinning knowledge and skills in the 'Evidence Guide' of specific units of competency in the National Electrotechnology Training Package and provides similar support, where mapped, to equivalent units in the National Metals and Engineering Competency Standards. For details refer to the module to unit maps, available from EEQSBA.

This module supports the development of essential capabilities required for electrical licensing.

5. Content

1. Power and power factor
   - true, apparent and reactive power
   - effects of low power factor
   - improvement
   - requirements
2. Multiphase systems
   - comparison of multiphase systems
   - advantage of three phase systems
3. Three phase principles
   - generation
   - relationship between generated voltages
   - phase sequence
4. Three phase star-connections
   - connections
   - line and phase voltages and currents
   - typical loads
5. Three phase four wire systems
   - purpose of neutral conductor
   - line and phase voltages and currents
   - neutral current
   - requirements
6. Three phase delta-connections
   - connections
   - line and phase voltages and currents
   - typical loads
7. Energy and power requirements of a.c. systems
   - purpose of energy, power, power factor and demand measurement
   - methods
   - power factor improvement

8. Harmonics
   - harmonics and selective resonance
   - sources in a.c. systems
   - problems

6. Assessment strategy

Assessment methods

Assessment should be progressive reflecting a holistic approach to ensure the module purpose is met. To assist in ensuring validity, reliability and fairness assessment instruments should include practical exercises, assignments and written tests consisting of a number of item types, such as multiple choice, short answer and problem solving.

Conditions of assessment

Normally learning and assessment will take place in a formal learning environment.

7. Learning outcome details

Learning outcome 1

Demonstrate an understanding of the consequences of low power factor and how this is dealt with in practice.

Assessment criteria

1.1 Explain the difference between true power, apparent power and reactive power and the units in which these quantities are measured.

1.2 Define the term “power factor”.

1.3 Describe the effects of low power factor.

1.4 Determine by measurement and calculation the power and power factor of a single phase circuit and the value of capacitance and/or reactive power required to improve the power factor to a specified value.

1.5 State local and AS/NZS 3000 requirements regarding the power factor of an installation and power factor improvement equipment.

Learning outcome 2

Demonstrate an understanding of the principle of multiphase systems and the reasons for the adoption of three phases for power systems.

Assessment criteria

2.1 Describe the features of a multiphase system.

2.2 Compare the voltages generated by single and multiphase alternators.

	2.3	List the reasons for the adoption of three phases for power systems.
Learning outcome 3	**Demonstrate an understanding of three phase principles and how three phases are generated.**	
Assessment criteria	3.1	Describe how three phases are generated in a single alternator.
	3.2	Calculate the r.m.s. value of voltage generated in each phase given the maximum value.
	3.3	Show the relationship between the phase voltages generated in a three phase alternator and the conventions for identifying each.
	3.4	Explain the term "phase sequence" (also, referred to as "phase rotation").
	3.5	Determine the phase sequence of a three phase supply.
Learning outcome 4	**Demonstrate an understanding of three phase star-connections.**	
Assessment criteria	4.1	Make a three phase star-connection.
	4.2	Show the phase relationship between line and phase voltages and line and phase currents of a star-connected system.
	4.3	Determine the r.m.s. value of line and phase voltage given any one of these quantities.
	4.4	Determine the r.m.s. value of line and phase current given any one of these quantities.
	4.5	Explain the terms "balanced load" and "unbalanced load".
	4.6	Give example of balanced and unbalanced loads in typical power systems.
Learning outcome 5	**Demonstrate an understanding of three phase four wire system.**	
Assessment criteria	5.1	Explain the purpose of the neutral conductor in a three phase four wire system.
	5.2	Determine the effects of a high impedance in the neutral conductor of a three phase four wire system supplying an unbalanced load where MEN earthing is employed.

	5.3	Determine the value and phase relationship of neutral current in an unbalanced three phase four wire system given line currents and power factors.
	5.4	State the Wiring Rules' requirements regarding neutral conductors.
Learning outcome 6	**Demonstrate an understanding of three phase delta-connections.**	
Assessment criteria	6.1	Make a three phase delta -connection.
	6.2	Show the phase relationship between line and phase voltages and line and phase currents of a delta - connected system.
	6.3	Determine the r.m.s. value of line and phase voltage given any one of these quantities.
	6.4	Determine the r.m.s. value of line and phase current given any one of these quantities.
	6.5	Give example of delta - connection loads in typical power systems.
Learning outcome 7	**Demonstrate an understanding of interconnected star and delta connected devices.**	
Assessment criteria	7.1	Show the relationship between line and phase voltages and line and phase currents in a system with a star-connected supply device and a delta-connected load.
	7.2	Show the relationship between line and phase voltages and line and phase currents in a system with a delta-connected supply device and a star-connected load.
Learning outcome 8	**Demonstrate an understanding of the energy and power requirements of a.c. power systems and loads and how these are dealt with in practice.**	
Assessment criteria	8.1	Explain the purposes for measuring power, energy, power factor and maximum demand of a.c. power systems and loads.
	8.2	Describe the methods used to measure power, energy power factor and maximum demand.
	8.3	Determine how the power factor of a three phase installation can be improved.

Learning outcome 9	**Identify sources that produce harmonics in a.c. power systems and the problems harmonics can cause.**
Assessment criteria	1.1 Define the terms "harmonic" and "selective resonance" in relation to the sinusoidal waveform of an a.c. power system. 1.2 List sources in a.c. systems that produce harmonics. 1.3 Describe some of the problems that may arise in a.c. circuits as a result of harmonics and how these are overcome.

8. Delivery of the module

Delivery strategy	Delivery strategies must be suitable for learning both theoretical and practical aspects described in the module purpose. It is considered that the most effective method to achieve this is by integration of theory and practice where students learn by experimentation, research and reports. It is recommended that learning and assessment be facilitated in a holistic manner that may require a learning outcome sequence other than that indicated in the module.
Resource requirements	Resources should be sufficient for students to carry out exercises on an individual basis. Useful references include: Jenneson, J. R. 1996, *Electrical Principles for Electrical Trades,* 4th Ed., McGraw Hill, Sydney Batty, I. 1996, *Electrical Principles*. Prentice Hall, Sydney. Van den Bergen, B. 1996, *Mathematics for the Electrical Trades*. TAFE Publications, RMIT, Melbourne Standards Australia, Standards New Zealand AS/NZS 3000:2000 *Wiring rules* AS/NZS 4836 *Safe working practice on low-voltage electrical installations* WorkCover Codes of practice

	Where this module is used in an approved Traineeship or Apprenticeship program learners should be advised to obtain, where available, respective EEQSBA[1] ***User Guides*** (*these outline in detail what training and work performance the Learner is required to undertake for the program*)
Occupational health and safety requirements	A safe and healthy environment will be provided for learners and teachers. Safety procedures for the particular learning facilities shall be followed as part of the learning / teaching activity and assessment.

[1] EEQSBA – ElectroComms and EnergyUtilities Qualifications Standards Body of Australia Ltd.