

1. Module details

Module name

Single & Three Phase Transformers

Suggested structured learning time

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

Module code

NUE048.1

Discipline code

0403120

2. Module purpose

This module provides the Learners with theory and practical applications for single and three-phase transformers. The module canvasses the construction of various types of transformers, their characteristics, performance parameters, connection techniques and testing requirements. Instrument transformers are included. Safety issues are also covered including those relating to high voltage.

3. Learning Pathway

Intended use in the structured learning program

This module is one of several that apply electrical theory to practical machines and situations and should be placed in a course of study when this can be accomplished. Therefore the module is intended to supplement extensive workplace exposure to the use and application of electrical equipment. In particular it applies to the safe application, installation, connection and fault finding of transformers. Before undertaking this module the learner should have a clear understanding and experience of electrical single and three-phase theory and a comprehensive knowledge of electromagnetism.

Recommended prerequisite modules

For the most effective learning, this module should be undertaken only after modules in applied electrical theory and electrical installation practices 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 other National Competency Standards. For details refer to the module to unit maps available from NUEITAB.

5. Content

1. Transformer construction and operating principles
 - basic construction
 - core construction
 - winding types
 - single wound
 - double wound
 - tapped windings
 - auto-transformers
 - applications and uses
 - operation and mutual induction
 - ideal and non ideal transformers
 - transformer on no load
 - transformer on load
 - nameplate details
 - relevant requirements of AS/NZS 3000:2000
 - relevant requirements of AS/NZS 3108:1994
2. Transformer parameters
 - winding resistance and reactance
 - percentage impedance
 - equivalent circuit
 - voltage regulation
 - transformer losses
 - efficiency
 - all day efficiency
3. Cooling methods
 - types /methods of cooling
 - relationship between rating and cooling
 - testing and maintenance of coolant

4. Auxiliary equipment
 - bushings
 - explosion vents
 - surge diverters
 - tap changers
 - conservator
 - breathers and desiccants
 - gas relays
 - temperature indicators
5. Instrument transformers
 - current transformers
 - ratings and burden
 - safety techniques
 - voltage transformers
 - ratings
6. Transformer connections
 - methods of connection
 - vector grouping
 - tertiary windings
7. Parallel operation
 - polarity markings
 - need for parallel operation
 - conditions for parallel operation
 - transformer load sharing
 - significance of vector group
8. Harmonics in transformers
 - causes
 - solutions
9. High voltage isolation

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	Learning and assessment will take place in an environment that is conducive to a learner's development.
7. Learning outcome details	
Learning outcome 1	Describe the construction and operation of transformers.
Assessment criteria	<ul style="list-style-type: none">1.1 Identify the various types of lamination style and core construction used in single-phase, three-phase, double wound and auto transformers.1.2 Identify the different winding styles/types used in transformers.1.3 Describe how input current is limited on no load and how power is transferred from primary to secondary when a load is connected.1.4 Use the transformation ratio to determine an unknown quantity of V, I, VA.1.5 State the significance of nameplate data items.1.6 Describe the operation of a transformer under load/no load conditions.1.7 State the reason any particular type of transformer is used in a specific application.1.8 Describe the safety features specified in AS/NZS 3000:2000 with respect to transformers.1.9 Describe the safety features specified in AS/NZS 3000:2000 with respect to isolating transformers.1.10 Perform basic insulation resistance, continuity and winding identification tests
Learning outcome 2	Explain and determine the main parameters of a transformer.
Assessment criteria	<ul style="list-style-type: none">2.1 Determine the percentage impedance of a transformer by test.

	2.2	Determine the percentage impedance of a transformer by calculation.
	2.3	Draw the equivalent circuit of a transformer.
	2.4	Explain and calculate voltage regulation
	2.5	Describe the losses that occur in a transformer.
	2.6	Perform tests to determine losses.
	2.7	Calculate efficiency and state typical values
	2.8	Calculate the all day efficiency of a transformer
Learning outcome 4		Describe the methods and equipment used to cool a transformer.
Assessment criteria	3.1	Describe methods of natural and forced cooling
	3.2	State properties of transformer oil.
	3.3	Describe tests performed on transformer oil.
Learning outcome 4		Describe the function and operation of transformer auxiliary equipment used on distribution transformers
Assessment criteria	4.1	Explain the purpose and operation of each type of auxiliary equipment used on transformers including: <ul style="list-style-type: none">• bushings• explosion vents• surge diverters• tap changers• conservator• breathers and desiccants• gas relays• temperature indicators
Learning outcome 5		Explain the operation and uses of instrument transformers
Assessment criteria	5.1	Describe the construction of current transformers
	5.2	State the uses and ratings of current transformers
	5.3	Describe the construction of voltage transformers
	5.4	State the uses and ratings of voltage transformers

	5.5	Describe safety techniques when using instrument transformers
Learning outcome 6		Describe the methods of connection and the vector groups of transformers
Assessment criteria	6.1	State vector group of a transformer from a connection diagram.
	6.2	Connect a three-phase transformer to create a particular vector group.
	6.3	Explain reasons for using the different vector groups
	6.4	Explain the purpose of tertiary windings
	6.5	Explain the consequences/effect of an incorrect connection
Learning outcome 7		Connect single and three-phase transformers in parallel.
Assessment criteria	7.1	Determine the polarity markings for the windings of a transformer
	7.2	State conditions/restrictions for parallel operation of transformers.
	7.3	Calculate loading on transformers operating in parallel.
	7.4	Connect transformers in parallel to supply a common load.
	7.5	Explain the consequences/effect of an incorrect connection
Learning outcome 8		Explain how harmonics are generated in transformers.
Assessment criteria	8.1	Explain how harmonics are generated in transformers
	8.2	State the problems caused by harmonics in transformers.
	8.3	Observe and measure the harmonics in a transformer
	8.4	State methods/equipment used to overcome harmonics in transformers
Learning outcome 9		Describe the safety aspects relating to the high voltage side of a power transformer
Assessment criteria	9.1	Define the term <i>high voltage</i>

8. Delivery of the module

Delivery strategy

- 9.2 State the procedures for isolating high voltage apparatus
- 9.3 State the regulations with respect to *access permits*
- 9.4 State clearances to be observed with respect to high voltages up to 33kV
- 9.5 Explain the term ‘step’ and ‘touch’ potential.

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 learning outcome sequence other than that indicated in the module.

Resource requirements

Resources should be sufficient for students to carry out experiments on an individual basis. This will require a range of experimental circuit devices and measuring instruments.

Useful references include:

Jenneson, J. R. 1996, *Electrical Principles for Electrical Trades*, 4Ed., McGraw Hill, Sydney

Van den Bergen, B. 1996, *Mathematics for the Electrical Trades*. TAFE Publications, RMIT, Melbourne

Standards Australia, Standards New Zealand:

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 EEQSBA¹ **User Guides** (*these outline in detail what training and work performance the Learner is required to undertake for the program*).

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

**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.