## 1. Module details

**Module name**

# Power System Protection

**Suggested structured learning time**

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

**Module code**

NUE399

**Discipline code**

## 2. Module purpose

This module aims to provide the student with an overview of the common protection systems and practices applied to power distribution systems. The module will concentrate on specific relay types or specialised schemes.

## 3. Learning pathway

**Intended use in the structured learning program**

**Recommended prerequisites**

For the most effective learning this module should be undertaken only after modules in three phase theory and transformers 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. Revision of system faults
   - type and classification of faults
   - three phase symmetrical fault levels
2. Protection fundamentals
   - purpose of protection
   - features of a protection scheme
3. Instrument transformers for protection
   - current transformers
   - voltage transformers
4. Feeder protection
   - fuse protection
   - overcurrent & earth fault
   - sensitive earth fault

- unit schemes
- distance protection
- trip/close sequences for feeders
- recloser/sectionaliser systems

5. Transformer protection
   - overheating protection
   - overcurrent protection
   - restricted earth fault protection
   - differential protection
   - oil and gas devices
6. Busbar protection
   - types of fault
   - requirements of busbar protection
   - system protection
   - frame-earth protection
7. Surge protection
   - voltage surges (revision)
   - surge diverters
   - arcing horns

## 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**

Calculate the three-phase symmetrical fault level at a given point in a power distribution system.

**Assessment criteria**

1.1 List the types of electrical fault that can occur on a power distribution system.

1.2 Given the source impedance, calculate the three-phase symmetrical fault level at a specified point in a power distribution system.

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| **Learning outcome 2** | Describe the need for protection of a power distribution system. |
| **Assessment criteria** | 2.1 State the need for a protection scheme to be applied to a power distribution system. |
| | 2.2 Define the terms reliability, selectivity, protection zones, speed, stability, sensitivity, primary protection and back-up protection. |
| **Learning outcome 3** | Describe the essential features of instrument transformers used in protection systems. |
| **Assessment criteria** | 3.1 Define the terms class, accuracy, ratio, error and burden as applied to current transformer used in a protection scheme. |
| | 3.2 Define the terms class, accuracy, ratio, error and burden as applied to voltage transformer used in a protection scheme. |
| | 3.3 Given the ratio for a current transformer or voltage transformer, determine the value of secondary current or voltage for specified primary values. |
| | 3.4 Given the ratio for a current transformer or voltage transformer, determine the value of primary current or voltage for specified secondary values. |
| | 3.5 Draw circuit diagrams depicting the necessary electrical connections to carry out ratio tests on current and voltage transformers. |
| | 3.6 Connect the necessary equipment, and carry out a test to verify the ration of a current or voltage transformer. |
| **Learning outcome 4** | Describe the essential operating features of specified feeder protection systems. |
| **Assessment criteria** | 4.1 Describe the use and limitations of fuses as protection for feeders in power distribution systems. |
| | 4.2 Describe the use and limitations of overcurrent and earth fault protection schemes for feeders in power distribution systems. |
| | 4.3 Draw a circuit diagram depicting the electrical connections for an overcurrent and earth fault protection scheme. |
| | 4.4 Describe the need and applications for sensitive earth fault protection as applied to feeder protection. |
| | 4.5 Describe, with the aid of circuit diagrams, the features and operating principles of circulating current protection scheme as applied to the protection of a feeder. |

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| | 4.6 Describe with the aid of circuit diagrams, the features and operating principles of distance protection as applied to the protection of a feeder. |
| | 4.7 Describe the need for, and the sequence of operation of a typical auto reclosing system as applied to a feeder protection scheme. |
| | 4.8 Describe with the aid of diagrams, the application and operation of recloser/sectionaliser protection schemes as applied to long rural, radial feeder systems. |
| **Learning outcome 5** | Describe the essential operating features of specified transformer protection systems. |
| **Assessment criteria** | 5.1 List the faults and circuit conditions that are likely to occur that influence the selection of protection methods for a power transformer. |
| | 5.2 Describe the need for overheating protection for power transformers. |
| | 5.3 Describe the methods employed to protect power transformers from overheating. |
| | 5.4 Describe the use and limitation of fuses as applied to power transformers for overcurrent protection. |
| | 5.5 Describe, with the aid of circuit diagrams, the application of overcurrent relays in the protection of power transformers. |
| | 5.6 Describe, with the aid of circuit diagrams, the operation and application of a restricted earth fault scheme to the protection of a power transformer. |
| | 5.7 Describe, with the aid of circuit diagrams, the features and operating principles of a differential protection scheme as applied to the protection of a power transformer. |
| | 5.8 Describe the need for, and the operating principles of oil and gas devices employed in the protection of power transformers. |
| **Learning outcome 6** | Describe the essential operating features of specified busbar protection systems. |
| **Assessment criteria** | 6.1 List the common faults that occur on a busbar system. |
| | 6.2 List the essential requirements of a busbar protection scheme. |

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| | 6.3 Describe the application and limitation of the system protection in the protection of a busbar system.<br>6.4 Describe, with the aid of circuit diagrams, the application and operating features of a three zone frame-earth protection scheme as applied to busbar protection. |
| **Learning outcome 7** | Describe the principles of surge protection as applied to power distribution systems. |
| **Assessment criteria** | 7.1 List the sources of, and typical levels of voltage surges that may occur on a power distribution system.<br>7.2 Describe the operating principles of a surge diverter as applied to power system protection.<br>7.3 Describe the principles involved in the selection of the location of surge diverters in a power distribution system.<br>7.4 Describe the application of arcing horns in the protection of equipment in a power distribution system. |

## 8. Delivery of the module

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| **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 Learners 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 Learners to carry out exercises on an individual basis.<br>Useful references include:<br>Jenneson, J. R. 1996, *Electrical Principles for Electrical Trades ,* 4th Ed., McGraw Hill, Sydney<br>Pethebridge, K., and Neeson, I., 2001, *Electrical Wiring Practice*, 6th Ed, Vol. 1 & 2., McGraw Hill, Sydney.<br>Standards Australia, Standards New Zealand:<br>AS/NZS 3000:2000 *Wiring rules*<br>AS/NZS 4836 *Safe working practice on low-voltage electrical installations* |

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| | HB3:1996 *Electrical and Electronic Drawing Practice for Learners*<br><br>Local electricity distributor and authority regulations.<br><br>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