1. Module details

Module name

Electricity Supply and Reticulation

Suggested structured learning time

A learner possessing the prerequisite skills and knowledge should achieve the module purpose in 72 to 80 hours.

Module code

NUE398

Discipline code

2. Module purpose

This module provides the student with instruction in the generation, transmission and distribution of electrical energy.

3. Learning pathway

Intended use in the structured learning program

It provides the student with an overview of the electrical operating characteristics of a power distribution system and concentrates on voltage problems and fault conditions in a power distribution system.

Further, it provides the student with the knowledge and skills in the metering and load control of an electrical distribution system.

Recommended prerequisites

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.

5. Content

1. Generation
   - definition
   - primary energy sources
   - power stations
   - power station output
   - acts and legislation relating to generation
   - renewable energy sources and techniques
2. Transmission
   - system requirements
   - principal components of a power system
   - voltage levels
   - grid systems
   - acts/legislation relating to transmission
   - future trends
3. Distribution
   - high voltage distribution systems

- medium/low voltage distribution systems
- radial feeders
- parallel feeders
- ring main feeders
- acts/legislation relating to distribution

4. Substations
   - purpose
   - location
   - layout
5. Overhead and underground systems
   - relative merits
   - applications
   - planning
   - installation
6. Power distribution system electrical characteristics
   - transmission and distribution systems
   - inductance, capacitance and resistance
7. Voltage problems in a power distribution system
   - low-voltage
   - unbalanced voltages
   - voltage rises
8. Voltage regulation
   - autotransformers with OLTC
   - transformers with OLTC
   - static capacitors
   - load control
9. Control of OLTC
   - regulation relays
   - control circuits
   - line drop compensation
10. Power distribution system faults
    - type/classification of fault
    - typical causes/effects of faults
    - three-phase symmetrical fault levels
    - fault level limitation
11. Voltage surges in a power distribution system
    - lightning surges
    - switching surges
    - typical surge levels
    - surge impedance, typical values
    - significance of the system surge impedance.

12. Metering
    - purpose

    Metered quantities
    - energy
    - maximum demand
    - accuracy classes for metering systems

13. Energy meters
    - construction
    - operation
    - adjustments
    - testing

    Demand meter
    - construction
    - operation

14. Metering circuits
    - direct metering
    - instrument transformer metering

15. Electronic metering systems
    - types
    - applications
    - connections

    Recording meters
    - types
    - applications
    - connections

16. Load control
    - purpose
    - methods

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	Describe the process known as generation and name the predominant types of generating systems used in Australia and the reasons for their adoption.	
Assessment criteria	1.1	Define generation.
	1.2	State the two main types of power station in Australia.
	1.3	Explain the reasons for power station location.
	1.4	Describe the overall layout of thermal and hydroelectric power stations.
	1.5	State typical operating speeds for thermal and hydroelectric generating sets.
	1.6	State typical generator voltage levels and output ratings.
	1.7	Name the body responsible for generation in a given state.
	1.8	Describe the renewable energy sources used to generate electricity.
Learning outcome 2	Explain the function of a transmission system within an overall power system	
Assessment criteria	2.1	State the basic requirements of a transmission system.
	2.2	Name the principal components of a power system.
	2.3	State typical voltage levels for primary and secondary transmission.
	2.4	Explain the advantages of a grid type transmission system.
	2.5	Interpret information from a single line diagram of a transmission system.
	2.6	Name the body responsible for transmission in a given state.
Learning outcome 3	Describe the need for a distribution system within an overall power system.	
Assessment criteria	3.1	Describe two methods of high voltage distribution.
	3.2	Describe four methods of medium/low voltage distribution.
	3.3	Identify radial, parallel and ring main feeders from a single line diagram.
	3.4	State the advantages and disadvantages of radial, parallel and ring main feeders.

	3.5	Name the body responsible for distribution in a given state.
Learning outcome 4	Explain the need for and the purpose of substations within an overall power system.	
Assessment criteria	4.1	State the reasons for incorporating substations in a power system.
	4.2	Describe how substations are located in relation to load centres.
	4.3	Describe the layout of high voltage equipment in a substation.
	4.4	List the auxiliary equipment used in substations.
	4.5	Interpret information from a single line diagram of the high-voltage equipment of a substation.
Learning outcome 5	Describe the relative advantages and disadvantages of overhead and underground supply systems within a power system.	
Assessment criteria	5.1	Describe the relative merits of overhead and underground systems.
	5.2	List applications for overhead systems in the areas of transmission and distribution.
	5.3	List applications for underground systems in the areas of transmission and distribution.
	5.4	State the basic steps involved in the planning of an overhead and an underground distribution line.
	5.5	State the basic steps involved in the installation of an overhead and an underground distribution line.
Learning outcome 6	Describe the electrical characteristics of a typical power distribution system.	
Assessment criteria	6.1	List the predominate electrical characteristics of overhead transmission and distribution feeders.
	6.2	List the predominate electrical characteristics of underground transmission and distribution feeders.
	6.3	Given the inductance in henries per kilometre of an overhead line or underground cable, calculate the inductive reactance.
	6.4	Given the capacitance in farads per kilometre of an overhead line or underground cable, calculate the capacitive reactance.

	6.5	Given the resistance in ohms per kilometre of an overhead line or underground cable, calculate the total resistance.
Learning outcome 7	List and describe the causes of voltage problems in a power distribution system.	
Assessment criteria	7.1	List the causes of low-voltage conditions in a power distribution system.
	7.2	List the causes of unbalanced voltage conditions in a power distribution system.
	7.3	List the causes of over-voltage conditions in a power distribution system.
	7.4	List the effects/consequences of low, unbalanced and over-voltage conditions in a power distribution system.
	7.5	Given the series reactance and resistance values for a distribution line calculate the voltage drop in the line for a specified load condition.
	7.6	Calculate the voltage regulation for a transmission or distribution feeder given the sending and receiving end voltages.
	7.7	List the accepted levels of voltage regulation for transmission and distribution feeder systems, taking into account local requirements.
Learning outcome 8	Describe the methods used to overcome voltage problems in a power distribution system.	
Assessment criteria	8.1	List the methods employed to overcome voltage problems in a power distribution system.
	8.2	Describe how a transformer or autotransformer equipped with an on load tap changing switch can be used to compensate for voltage fluctuations in a power distribution system.
	8.3	Describe how on load tap changing switches in transformers and autotransformers are controlled with the aid of voltage regulation relays.
	8.4	Describe the purpose of a line drop compensator in a voltage regulation relay circuit.
	8.5	Draw a circuit diagram depicting the control circuit for an on load tap changer incorporating a voltage regulation relay and a line drop compensator unit.

	8.6	Describe how static capacitors may be used to compensate for voltage problems in a transmission system.
	8.7	Describe how load control may be used to compensate for voltage problems in a distribution system.
Learning outcome 9	List and describe the electrical faults that can occur in a power distribution system.	
Assessment criteria	9.1	List the types of electrical fault that occur on a power distribution system.
	9.2	Describe the cause and effect of the electrical faults that occur on a power distribution system.
Learning outcome 10	Calculate the three-phase symmetrical fault level at a given point in a power distribution system and describe the methods that may be used to limit fault currents in a power distribution system.	
Assessment criteria	10.1	State that, with respect to fault currents, a three-phase symmetrical fault is the most severe fault that can occur on a power distribution system.
	10.2	Describe the need to calculate fault levels in a power distribution system.
	10.3	Given the source impedance or fault capacity, calculate the three-phase symmetrical fault level at a given point in a power distribution system.
	10.4	Describe the need to limit the fault level at particular points in a power distribution system.
	10.5	Describe the methods that may be used to limit the fault level in power distribution system.
Learning outcome 11	Describe the causes and effects of voltage surges on a power distribution system.	
Assessment criteria	11.1	Describe the causes of voltage surges in a power distribution system.
	11.2	Describe the effects of voltage surges on a power distribution system.
	11.3	Quote typical voltage surge levels in a power distribution system.
	11.4	Describe the effect of a change in the system surge impedance on a voltage surge.
Learning outcome 12	Describe the need for metering systems within a distribution network and the accuracy class of the meters used.	

Assessment criteria	12.1	State two reasons for the use of a metering system.
	12.2	State the two quantities measured for revenue purposes.
	12.3	State the standard unit for energy measurement.
	12.4	State the standard units for demand measurement.
	12.5	List installations where electricity consumption is measured in terms of energy.
	12.6	List installations where electricity consumption is measured in terms of demand.
	12.7	Describe the term accuracy class as applied to meters used in a distribution system.
	12.8	State the meaning of the term accuracy class 0.2 and 0.5
	12.9	List examples of installations where meters of accuracy class 0.2 and 0.5 are acceptable.
Learning outcome 13	Describe the basic operation of the kilowatt-hour and maximum demand meters and state their respective functions.	
Assessment criteria	13.1	Identify the major component parts of the kilowatt-hour meter.
	13.2	Describe the operation of the kilowatt-hour meter.
	13.3	State the adjustments available on the kilowatt-hour meter.
	13.4	State the function of a rotary standard.
	13.5	Correctly perform standard tests on a kilowatt-hour meter.
	13.6	List three types of demand meter.
	13.7	Identify the major component parts of a demand meter.
	13.8	Describe the operation of a thermal demand meter.
Learning outcome 14	Correctly connect the kilowatt-hour and maximum demand meters.	
Assessment criteria	14.1	Correctly connect a single-phase kilowatt-hour meter.
	14.2	Correctly connect a polyphase kilowatt-hour meter.
	14.3	Correctly connect a demand meter.
	14.4	State the need for current and potential transformers in distribution metering.

	14.5	Correctly connect medium/low-voltage, high current energy and demand metering.
	14.6	Draw the circuit diagram of high-voltage, high current energy and demand metering.
Learning outcome 15	List the applications for electronic and recording type meters within a distribution system.	
Assessment criteria	15.1	List the electronic metering systems available for distribution systems.
	15.2	Draw the connections for the measurement of energy and demand using electronic meters.
	15.3	List applications for recording type meters in a distribution system.
	15.4	State the advantages of recording type meters.
	15.5	Draw the connections for recording type meters.
Learning outcome 16	Explain the need for and the purpose of load control within a distribution system.	
Assessment criteria	16.1	State the purpose of load control in a distribution system.
	16.2	List three methods of load control.
	16.3	Describe the operation of three methods of load control.
	16.4	Draw circuit diagrams showing how load control devices are connected into the system.

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 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.

Useful references include:

	Standards Australia, Standards New Zealand:
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.