1. Module details

Module name

Applied Electricity - d.c. circuits

Suggested structured learning time

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

Module code

NUE049

Discipline code

0703110

2. Module purpose

This module provides Learners with knowledge and skills in electrical measurement and in working with and solving problems in series, parallel and series/parallel, single source dc circuits.

Learners will gain an understanding of the relationship between voltage and current and develop skills in working safely with circuits and using and caring for electrical measuring instruments

It covers basic and derived units of mechanical and electrical measurement and develops Learners skills to manipulate equations to solve problems involving these units. Learners will gain knowledge in the principles of electrical conduction, the electrical characteristics of material and the conversion of electrical energy to other forms and visa versa. Also, they will gain knowledge of common resistor types and the factors affecting resistance and the basic concepts of capacitance and inductance

Physiological and damaging effects of current and how these are dealt with in practice are also covered.

3. Learning Pathway

Intended use in the structured learning program

This module is an introduction to electrical theory and is intended to supplement exposure to electrical/ electronic work. Before undertaking this module a Learners should have a general understanding what electrical/electronic work entails and the need to work safely particularly when dealing with electricity.

Recommended prerequisite modules

Mathematical skills equivalent to NUE 053

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. Fundamental and derived units
    - basic units
    - SI derived units
        - Mechanical
        - Electrical
    - multiples and sub-multiples
2. Power, work and energy
    - conservation of energy
    - torque
    - losses and efficiency
    - maximum efficiency of machines
3. Electrical characteristics of materials
    - electric theory
    - conductors
    - insulators
    - semi-conductors
    - electric charge
    - electric current
    - electromotive force
4. The simple circuit
    - source of electrical energy, load, current path, control
    - open-circuit
    - short-circuit
5. Resistance
    - Ohm's law
    - determine V, I, R,
    - power dissipation

6. Effects of current
   - physiological effects
   - principles of protection from physiological effects
7. Effects of current -
   - conversion of electrical energy to other forms
     - heating
     - light
     - magnetic
     - chemical
   - principles of protection from damaging effects
8. Sources of electrical energy - conversion of other forms to electrical energy
   - single emf source equivalent circuit
   - chemical reaction (primary cells, secondary cells and fuel cells)
   - magnetism and rotational motion
   - light
   - heat
   - force
9. Using measuring instruments
   - handling measuring instruments
   - selecting an instrument
   - setting-up and connecting into circuits
   - reading scales and read-outs
   - setting up a CRO
10. Factors affecting resistance
    - length, csa, resistivity
    - temperature change
    - influence on practical circuits
11. Resistors
    - types and applications
    - value and rating

12. Series circuits
    - determine V, I, R, P
    - Kirchhoff's Voltage Law ($\sum Vd = E$)
    - voltage divider
    - series connection of cells
13. Parallel circuits
    - determine V, I, R, P
    - Kirchhoff's Current Law ($\sum Iin = \sum Iout$)
    - current divider
    - parallel connection of cells
14. Series / parallel circuits
    - determine V, I, R, P
    - bridge network
    - series/parallel connection of cells
15. Resistance measurement
    - hazards
    - characteristics of instruments and loading effect
    - direct, volt-ammeter and bridge method
    - typical field instruments and applications (introduction)
16. Capacitance
    - concept
    - units
    - time constant relationship
17. Capacitors
    - hazards
    - factors affecting capacitance
    - in series
    - in parallel
    - measuring / testing

18. Inductance

- concept
- units
- time constant relationship
- factors affecting inductance

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

Use fundamental and derived units in the calculation of electrical and related mechanical quantities

Assessment criteria

1.1 Identify the basic units of measurement

1.2 Define the SI derived units for force, pressure, energy/work temperature and power

1.3 Convert units to multiple and submultiple units

1.4 Transpose a given equation for any variable in the equation

1.5 Perform basic calculations of electrical and related mechanical quantities given in any combination of units, multiple units or submultiple units.

Learning outcome 2

Explain the principle of the conservation of energy and the effects of losses in electrical systems and machines

Assessment criteria

2.1 Show the relationship between power, work and energy

2.2 Determine the input, output, efficiency or losses of electrical systems and machines in terms of units / multiple units of power

	2.3	State the effect of losses in electrical wiring and machines.
Learning outcome 3	Explain the physical and electrical characteristics of materials	
Assessment criteria	3.1	List the characteristics of solid conductors, electrolytes, insulators and semi-conductors
	3.2	Describe the mechanisms of electrical conduction in solids, liquids and gases
	3.3	Define the terms “electric charge”, “electric current” and “electromotive force.”
Learning outcome 4	Set-up and operate simple single load electrical circuit incorporating a switch and circuit protection device.	
Assessment criteria	4.1	Identify symbols used to represent an electrical energy source, a load, a switch and a circuit protection device in circuit diagram
	4.2	Describe the purpose of each component in the circuit
	4.3	Observe and describe the effects of an open-circuit, a closed-circuit and a short-circuit.
Learning outcome 5	Demonstrate an understanding of the relationships between voltage, current and resistance and the power dissipated in a circuit.	
Assessment criteria	5.1	Show the relationship between voltage and current from measured values in a simple circuit
	5.2	Calculate the voltage, current and resistance in a circuit given any two of these quantities
	5.3	Calculate the power dissipated in a circuit from voltage, current and resistance values
	5.4	Explain the relationship between voltage, current and resistance and the power dissipated in a circuit.
Learning outcome 6	Demonstrate an understanding of the physiological effects of current the principles for protection against these effects.	
Assessment criteria	6.1	Describe the physiological effects of current
	6.2	Describe the fundamental principles (listed in AS 3000) for protection against the physiological effects of current.

Learning outcome 7	Describe the effects of electric current in terms of the conversion of electrical energy to other forms and the uses and disadvantages of these effects.
Assessment criteria	7.1 Outline the basic principles by which electric current can result in the production of heat; the production of light; the production of magnetic fields; a chemical reaction 7.2 List typical uses of the effects of current 7.3 Describe the mechanisms by which metals corrode 7.4 Describe the fundamental principles (listed in AS 3000) for protection against the damaging effects of current.
Learning outcome 8	Describe how other forms to electrical energy are converted to electrical energy and where each is used.
Assessment criteria	8.1 Outline the basic principles by which electricity is produced from a chemical reaction (primary cells, secondary cells and fuel cells); produced from a magnetic field coupled with motion; produced from light; produced from heat; produced from force. 8.2 Draw a single cmf source equivalent circuit.
Learning outcome 9	Use digital and analogue instruments to measure voltage, current and resistance.
Assessment criteria	9.1 Apply safe working procedures when working with instruments 9.2 Handle and store instruments to ensure they are protected from damaged 9.3 Select and set-up an instrument to measure voltage, current or resistance 9.4 Connect instruments into a circuit to measure voltage, current and resistance 9.5 Read analogue scales and digital readouts in measuring voltage, current and resistance 9.6 Set-up a Cathode Ray Oscilloscope to measure d.c. and a.c. voltages.
Learning outcome 10	Discuss the factors affecting resistance and determine their influence on practical circuits and devices.

Assessment criteria	10.1 Show how length, cross-sectional area and material effect the resistance of conductors
	10.2 Describe effects of temperature change on the resistance of various conducting materials
	10.3 Determine the resistance of a conductor from factors such as conductor length, cross-sectional area, resistivity and changes in temperature
	10.4 Explain the effects of resistance on the current-carrying capacity and voltage drop in cables.
Learning outcome 11	Discuss the features of common practical resistors and determine the suitability of a resistor for a given purpose.
	11.1 Describe the features of fixed and variable resistor types and typical applications
	11.2 List the characteristics of temperature, voltage and light dependent resistors and typical applications of each
	11.3 Specifying a resistor for a particular application
	11.4 Determine the resistance of a colour coded resistor from colour code table and confirm the value by measurement.
Learning outcome 12	Work with single-source series dc circuits and solve problems related to voltages, currents, resistances and power dissipated in such circuits.
	12.1 Set up and connect a single-source series dc circuit
	12.2 Take resistance, voltage and current measurements in a single source series circuit
	12.3 Determine the voltage, current, resistances or power dissipated from measured or given values of any two of these quantities
	12.4 Describe the relationship between the voltage drops around a circuit and the applied voltage
	12.5 Show the relationship between voltage drops and resistance in a simple voltage divider network.
	12.6 Determine the output voltage and current levels of connecting cells in series.

Learning outcome 13	Work with single-source parallel circuits and solve problems related to voltages, currents, resistances and power dissipated in such circuits. 13.1 Set up and connect a single-source parallel circuit 13.2 Take resistance, voltage and current measurements in a single-source parallel circuit 13.3 Determine the voltage, current, resistance or power dissipated from measured or given values of any of these quantities 13.4 Describe the relationship between currents entering a junction and currents leaving a junction 13.5 Show the relationship between branch currents and resistances in a two branch current divider network. 13.6 Determine the voltage and current levels of connecting cells in parallel.
Learning outcome 14	Work with single source series / parallel circuits and solve problems related to voltages, currents, resistances and power dissipated in such circuits. 14.1 Set up and connect a single-source series / parallel circuit 14.2 Take resistance, voltage and current measurements in a single-source series / parallel circuit 14.3 Determine the voltage, current, resistances or power dissipated from measured or given values of any two of these quantities 14.4 Show the relationship between voltages, currents and resistances in a bridge network. 14.5 Determine the voltage and current levels of connecting cells in series parallel.
Learning outcome 15	Take accurate measurements of voltage, current and resistance and identify typical instruments used in the field**.** 15.1 Identify the hazards involved in using electrical instruments and the safety control measures that should be taken 15.2 Compare the operating characteristics of analogue and digital meters

	15.3 Select an appropriate meter in terms of units to be measured, range, loading effect and accuracy for a given application
	15.4 Measure resistance using direct, volt-ammeter and bridge methods
	15.5 Identify instruments used in the field to measure voltage, current and resistance and the typical circumstances in which they are used.
Learning outcome 16	Demonstrate an understanding of the concepts of capacitance, the units by which it is measured and the characteristics of series dc circuits containing resistance and capacitance.
	16.1 Define capacitance and explain how a capacitor is charged
	16.2 Define the units by which capacitance is measured
	16.3 Show the relationship between capacitance, voltage and charge
	16.4 Show how a series d.c. circuit containing resistance and capacitance behaves.
Learning outcome 17	Discuss the factors affecting capacitance and methods for measuring / testing capacitors.
	17.1 Identify the hazards involved in working with capacitance effects and the safety control measures that should be taken
	17.2 List the factors which determine the capacitance of a capacitor and explain how these factors are present in all circuits to some extent
	17.3 Show the effects of capacitors connected in parallel by calculating their equivalent capacitance
	17.4 State the effects on the total capacitance of capacitors connected in series
	17.5 Describe common faults in capacitors
	17.6 Determine through measurement whether a given capacitor is serviceable.
Learning outcome 18	Demonstrate an understanding of the concepts of inductance, the units by which it is measured and the characteristics of series dc circuits containing resistance and inductance.

18.1 Define inductance and explain how an inductor stores energy in the form of a magnetic field

18.2 Define the units by which inductance is measured

18.3 Show how a series d.c. circuit containing resistance and inductance behaves

18.4 List the factors which determine the inductance of an inductor and explain how these factors are present in all circuits to some extent

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 learning outcome sequence other than that indicated in the module.

Resource requirements

Resources should be sufficient for learners to carry out learning activities on an individual basis.

Suggested Learning Resource:

Jenneson, J. R. 1995*, Electrical Principles for Electrical Trade.* 4th Ed. McGraw Hill, Sydney

Phillips, P. 1996, *Electrical Principles* 1. Thomas Nelsen, Melbourne

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 4836 *Safe working practice on low-voltage electrical installations*

Local electricity distributor and authority regulations.

	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