1. Module details

Module name

Applied Electromagnetism

Suggested structured learning time

A learner possessing the prerequisite skills and knowledge should achieve the module purpose in 54 to 60 hours.

Module code

NUE045

Discipline code

0703120

2. Module purpose

This module prepares Learners for further learning in the power applications of electricity. Learners will gain knowledge of the laws of electromagnetism and inductance and how they apply to the basic principles of electrical devices and machines.

They will learn terms used in magnetic, the hazards related to induced voltages and develop skills in solving basic problems involving electromagnetics and inductance. Learners will also gain the knowledge and understanding of the operation and applications of machines.

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 work related to the application of electromagnetism and more importantly the adverse effects and hazards of unwanted induced voltages.

Therefore before undertaking this module Learners should have a understanding and experience of electrical work in general and how the fundamental principles for safety apply.

Recommended prerequisites

For the most effective learning this module should be undertaken only after modules in occupational health and safety and d.c. circuits 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. Magnetism
   - field patterns
   - magnetic induction & its effects
   - magnetic screening and applications
   - applications of permanent magnets
2. Electromagnetism
   - direction of magnetic field
   - polarity of field
3. Magnetic quantities
   - magnetic units (magnetomotive force, magnetising force, flux density, reluctance) permeability
   - calculation of magnetic units
4. Magnetisation curve
   - magnetic characteristics of materials using magnetisation curves & hysteresis loops
   - saturation, hysteresis and losses
   - magnetic losses
5. Electromagnetic Induction
   - Faraday's law, factors required to induce an emf
   - Fleming's right hand rule
   - forces acting on a conductor (Lenz's law)
6. Inductance
   - concept of inductance, self inductance and mutual inductance
   - factors affecting inductance and unit of inductance
   - inductance of a solenoid
   - calculation of induced voltage
   - L R circuits
7. Application of electromagnetic principles
   - common applications of magnetic devices
   - hazards associated with induced voltages
   - adverse effect of inductance and electromagnetism

8. Rotating machine construction and operating principles
   - construction of rotating machines
   - generated emf and back emf
   - development of torque
   - factors affecting generated voltage and torque
9. DC Generators
   - circuit diagrams and connections
   - methods of excitation
   - control of output voltage
   - effects of load
10. DC Motors
    - circuit diagrams and connections
    - evaluation of performance of motor
    - effects of load

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 magnetism, magnetic induction the nature of magnetic materials and their application.

Assessment criteria

1.1 Show the field patterns around given permanent magnets.

1.2 Explain magnetic induction and its effects.

1.3 Describe the principles of magnetic screening and its application.

	1.4 List typical applications of permanent magnets.
Learning outcome 2	Demonstrate an understanding of magnetic fields associated with straight and coiled carrying-current conductors and resultant forces between adjacent conductors carrying current.
Assessment criteria	2.1 Show the magnetic field patterns around a straight conductor and a solenoid carrying current.
	2.2 Apply the right-hand thumb rule- straight conductor to determine the direction in which the magnetic field around a current-carrying conductor acts.
	2.3 Apply the right-hand thumb rule – solenoids to determine the direction of the north pole of a solenoid
	2.4 Describe the factors effecting the force between adjacent current-carrying conductors, calculate the force, and state its direction.
Learning outcome 3	Describe the relationship between magnetomotive force, magnetising force, flux density, permeability and reluctance in magnetic circuits and perform calculations to determine these quantities.
Assessment criteria	3.1 Explain how the magnetic units for magnetomotive force, magnetising force, flux density and reluctance are defined.
	3.2 Explain the property of permeability and the meaning of actual and relative permeability.
	3.3 Calculate values of magnetomotive force, magnetising force, flux density, permeability and reluctance in given magnetic circuits.
Learning outcome 4	Compare the magnetic characteristics of various materials and explain the terms “saturation”, “hysteresis” and “losses” and their effect in the performance of electrical machines.
Assessment criteria	4.1 Define the terms “saturation”, “hysteresis” and “losses’ in relation to magnetic materials and circuits.
	4.2 Compare the magnetic characteristics of various materials from magnetisation curves and hysteresis loops.
	4.3 Explain how magnetic losses occur and the resulting effects on the performance of electrical machines.

Learning outcome 5	Demonstrate an understanding of the principles by which an e.m.f. is induced in a conductor, the magnitude of the induced e.m.f. and the direction in which it acts.	
Assessment criteria	5.1	List the factors required to induce an emf in a conductor.
	5.2	State Faraday's Law and apply it to simple calculations
	5.3	Apply Fleming's right hand rule to moving conductors in a magnetic field
	5.4	Explain the relationship between the forces acting on a closed conductor when an emf is induced in it. (Lenz's law).
Learning outcome 6	Explain the concepts of inductance, the units by which it is measured and the relationship between the factors determining the inductance of a circuit.	
Assessment criteria	6.1	Explain the concept of inductance, self-inductance and mutual inductance. (in terms of storage of magnetic energy)
	6.2	Describe the factors affecting inductance and how the unit of inductance is derived.
	6.3	Determine the inductance of a solenoid given necessary physical data
	6.4	Calculate the value of induced voltage in a given circuit.
	6.5	Describe the growth/decay of current in an inductor and determine the time constant of a series L-R circuit
Learning outcome 7	Describe how electromagnetic principles can be applied to electrical machines and devices.	
Assessment criteria	7.1	Use and explain the principles of operation and applications of magnetism, electromagnetism and induction.
	7.2	Explain the hazards associated with induced voltages.
	7.3	Identify situations where the effects of inductance and electromagnetism has an adverse effect.
Learning outcome 8	Describe the principle of operation and construction of machines.	

Assessment criteria	8.1 Identify the main components of a direct current rotating machine.
	8.2 Using simple diagrams, describe how a d.c. voltage is generated and how a back emf is induced in the armature conductors of a d.c. motor.
	8.3 Describe how the motor effect is produced by an electric current, including the development of torque in a motor and opposing torque in a generator.
	8.4 Perform simple calculations to determine the induced voltage in a conductors, force on a conductor and torque of various machines. Note: Use only v = Blv, F = Bli, T= Force x radius
Learning outcome 9	Describe the operating principles and characteristics of d.c. generators.
Assessment criteria	9.1 Draw the circuit arrangement and connect various types of generators.
	9.2 List and describe the common methods of excitation used for generators.
	9.3 Describe the methods used to regulate the output voltage of generators.
	9.4 Describe the effects of load on a generator.
Learning outcome 10	Describe the operating principles and characteristics of motors including starting.
Assessment criteria	10.1 Draw circuit arrangements and connect various common motors.
	10.2 Evaluate the performance of motors from measured values.
	10.3 Describe the effects of load on a motor.
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 learning activities on an individual basis. *Suggested Learning Resource:* 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 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 – E lectroComms and EnergyUtilities Qualifications Standards Body of Australia Ltd.