Australian Government

MARL6001A Apply intermediate principles of marine electrotechnology

Release 1

INDUSTRY SKILLS COUNCILS
Creating Australia's Future

MARL6001A Apply intermediate principles of marine electrotechnology

Modification History

Release 1
This is the first release of this unit.

Unit Descriptor

This unit involves the skills and knowledge required to explain intermediate marine electrotechnology principles and perform intermediate electrical calculations.

Application of the Unit

This unit applies to the work of a Marine Engineer Class 2 on commercial vessels greater than 3000 kW and forms part of the requirements for the Certificate of Competency Marine Engineer Class 2 issued by the Australian Maritime Safety Authority (AMSA).

Licensing/Regulatory Information

Not applicable.

Pre-Requisites

Not applicable.

Employability Skills Information

This unit contains employability skills.

Elements and Performance Criteria Pre-Content

Elements describe the essential outcomes of a unit of competency.	Performance criteria describe the required performance needed to demonstrate achievement of the element. Assessment of performance is to be consistent with the evidence guide.

Elements and Performance Criteria

1	**Apply concepts of resistivity, resistance and capacitance to series and parallel AC and DC circuits**	1.1	Calculations are performed to solve problems related to resistance, voltage drop, current and power in series and parallel circuits
		1.2	Calculations are performed to solve problems related to temperature coefficient of resistance and change of resistance of a conductor with a change of temperature
		1.3	Basic relationships that give total equivalent capacitance for capacitors arranged in series and parallel combinations are derived
		1.4	Relationships that give total equivalent capacitance to solve numeric problems involving alternating current (AC) and direct current (DC) circuits are applied
2	**Explain how principles of electrolytic action apply to electrical cells and batteries**	2.1	Kirchhoff's circuit laws are explained
		2.2	Calculations to solve problems involving currents, voltage drop and terminal potential difference for cells connected to form batteries in series and in parallel are performed
		2.3	Calculations to solve secondary cell charging and discharging problems are performed
		2.4	Calculations to solve problems related to the efficiency of cells are performed
3	**Analyse a magnetic circuit**	3.1	***Key parameters of magnetic circuits*** are identified
		3.2	Formula for calculating the amount of flux generated by a multi turn solenoid coil carrying a current to give the B/H relationship is applied
		3.3	Significance of the varying slopes in the B/H curves for a solenoid coil with air, cast iron, cast steel and mild steel cores is explained
		3.4	How a magnetic circuit may be created by using a toroidal core within the solenoid coil is shown
		3.5	Calculations to solve problems relating to magnetic circuits using different materials in different parts of their cores, including air gaps, are performed

	3.6	Effect on flux density of applying an alternating magnetising force to an iron core is shown diagrammatically
4 Interpret electromagnetic consequences of a conductor moving relative to a magnetic field	4.1	Faraday's and Lenz's Laws are applied to solve problems relating to the electromagnetic induction of EMF and current
	4.2	Generation of EMF is illustrated by a simple, single loop conductor rotating in a uniform magnetic field and how this EMF may be tapped to an external circuit as either AC or DC is explained
	4.3	How alternating electrical quantities may be represented by rotating phasors is illustrated and explained
	4.4	Relationships between instantaneous, maximum, average and RMS values of sinusoidally alternating electrical quantities is derived
	4.5	Mathematical problems are solved by applying relationships between instantaneous, maximum, average and RMS values of sinusoidally alternating electrical quantities
5 Analyse circuits that incorporate combinations of resistive, inductive, and capacitive elements	5.1	Time constant for different ***circuit combinations*** subjected to DC EMF's is defined
	5.2	Calculations are performed to solve problems involving time constants in DC circuits with changing rates of current in resistive/inductive elements and changing voltages through resistive/capacitive circuit elements
	5.3	Differentiation is made between inductive reactance, capacitive reactance and impedance as applied to AC circuits
	5.4	Effects of inductive and capacitive reactance upon phasor relationships between applied AC voltage and current are shown
	5.5	Concept of total impedance is applied to solution of problems involving single phase AC quantities in the presence of both resistive/inductive and resistive/capacitive circuit elements, arranged in either series or parallel

	5.6 Power factor is defined and concepts of real and reactive power usage are applied to solution of problems involving RL and RC elements
6 Analyse operation of polyphase AC circuits	6.1 How three phase AC may be developed out of simple single phase AC is explained
	6.2 Voltage and current relationships between line and phase in both Star and Delta 3 phase connections are derived
	6.3 Standard Star to Delta and Delta to Star conversion relationships for current and voltage are derived
	6.4 Numeric problems involving both balanced and unbalanced circuit loads are solved
	6.5 Relationships between kW, kVA and kVAr for 3 phase AC circuits is derived
	6.6 Calculations are performed using the relationship between kW, kVA and kVAr to solve problems in 3 phase AC circuits
7 Describe basic operating principles of shipboard DC machinery	7.1 Schematic circuits are prepared for separately excited, series, shunt and compound connected generators and motors to illustrate wiring arrangements used with DC machines
	7.2 EMF equation for a DC generator to solve shipboard problems is applied
	7.3 Torque equation for a DC motor to solve shipboard problems is applied
	7.4 Expression linking back EMF parameters for a DC motor is derived and used to solve shipboard problems
	7.5 Various ***losses*** that can occur in DC motors and generators are calculated
8 Perform calculations related to operation of AC generators	8.1 Construction features of the AC synchronous generator are explained
	8.2 EMF equation for an AC generator is derived, taking into account distribution and pitch factors
	8.3 Expression for the magnitude and speed of the rotating flux generated by a three-phase supply is

		derived
	8.4	Voltage regulation for synchronous generator is defined
	8.5	Effect of power factor on load characteristic of an AC generator is illustrated
9 Perform calculations related to operation of three-phase AC induction motors	9.1	Construction features of the AC induction motor are explained
	9.2	Expression for slip of an induction motor rotor is derived and applied to frequency of its rotor EMF and current
	9.3	Expression for magnitude of rotor EMF and current is derived, taking into account distribution and pitch factors
	9.4	Relationships between rotor torque, rotor losses and slip indicating factors that affect torque are outlined
	9.5	Significance of torque/slip curves for an induction motor is explained
	9.6	Relationship between starting torque and applied voltage is established and consequences of this upon starting methods are outlined
10 Explain operating principles of basic electrical instrumentation	10.1	Schematic circuit diagrams are prepared that illustrate the main features and applications of moving coil and moving iron voltmeters and ammeters
	10.2	Schematic circuit diagrams are prepared that illustrate the main features and applications of air and iron cored dynamometer type wattmeters
	10.3	Dangers associated with current and voltage transformers on high current and voltage systems are identified

Required Skills and Knowledge

This section describes the skills and knowledge required for this unit.

Required Skills:

- Assess own work outcomes and maintain knowledge of current codes, standards, regulations and industry practices
- Explain intermediate principles of marine electrotechnology
- Explain Faraday's and Lenz's Laws of Electromagnetic Induction
- Identify and apply relevant mathematical formula and techniques to solve problems related to marine electrotechnology
- Identify and interpret numerical and graphical information, and perform mathematical calculations such as the relationship between starting torque and applied voltage in three phase AC induction motors
- Identify, collate and process information required to perform calculations related to marine electrotechnology
- Impart knowledge and ideas through verbal, written and visual means
- Read and interpret written information needed to perform intermediate electrical calculations
- Use calculators to perform mathematical calculations

Required Knowledge:

- AC induction motors
- AC principles
- Batteries
- Circuit diagrams
- DC motors
- Difference between AC and DC
- Electrical:
  - current
  - power
  - units of measurement
- Electromagnetic:
  - force
  - induction
- Intermediate electrical circuits
- Kirchhoff's circuit laws
- Magnetic circuits
- National and international maritime regulations, IMO Conventions and Codes applicable

to the operation of electrical and electronic control equipment on vessels of typically unlimited propulsion power

- Ohm's Law
- Polyphase AC circuits
- Principles of:
  - electrical safety
  - electrolytic action
  - electromagnetism
- Parallel circuits
- Principles and procedures for electrical and electronic measurement
- Series circuits
- Shipboard DC machinery
- Work health and safety (WHS)/occupational health and safety (OHS) requirements and work practices

Evidence Guide

The evidence guide provides advice on assessment and must be read in conjunction with the performance criteria, the required skills and knowledge, the range statement and the Assessment Guidelines for the Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit	The evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the Elements, Performance Criteria, Required Skills, Required Knowledge and include: • making accurate and reliable calculations • solving problems using appropriate laws and principles.
Context of and specific resources for assessment	Performance is demonstrated consistently over time and in a suitable range of contexts. Resources for assessment include access to: • industry-approved marine operations site where intermediate principles of marine electrotechnology can be applied • electrical diagrams, specifications and other information required for performing intermediate electrical calculations • technical reference library with current publications on intermediate marine electrotechnology • tools, equipment and personal protective equipment currently used in industry • relevant regulatory and equipment documentation that impacts on work activities • range of relevant exercises, case studies and/or other simulated practical and knowledge assessments • appropriate range of relevant operational situations in the workplace. In both real and simulated environments, access is required to: • relevant and appropriate materials and equipment • applicable documentation including workplace procedures, regulations, codes of practice and operation manuals.
Method of assessment	Practical assessment must occur in an: • appropriately simulated workplace environment and/or • appropriate range of situations in the workplace. A range of assessment methods should be used to assess practical skills and knowledge. The following examples are appropriate to this unit: • direct observation of the candidate applying intermediate

	principles of marine electrotechnology • direct observation of the candidate applying relevant WHS/OHS requirements and work practices.
Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. In all cases where practical assessment is used it should be combined with targeted questioning to assess Required Knowledge. Assessment processes and techniques must be appropriate to the language and literacy requirements of the work being performed and the capacity of the candidate.

Range Statement

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the performance criteria, is detailed below.

Key parameters of magnetic circuit may include:	• Current • Flux • Flux density • Magnetising force • Magneto motive force
Circuit combinations may include:	• Resistive/capacitive • Resistive/inductive
Losses may include:	• Copper losses • Iron losses or magnetic losses • Mechanical losses

Unit Sector(s)

Not applicable.

Competency Field

Marine Engineering