



Australian Government

MARL6005A Apply advanced principles of marine electrotechnology

Release 1

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Modification History

Release 1

This is the first release of this unit.

Unit Descriptor

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

Application of the Unit

This unit applies to the work of a Marine Engineer Class 1 on commercial vessels of unlimited propulsion power and forms part of the requirements for the Certificate of Competency Marine Engineer Class 1 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

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| 1 Analyse circuits incorporating resistance, inductance and capacitive elements | 1.1 Mathematical problems involving RL and RC combinations in direct current (DC) circuits are solved

1.2 Mathematical problems involving resistive, inductive and capacitive reactance and overall circuit impedance in alternating current (AC) circuits are solved

1.3 Why large power factors are desirable in AC circuits is explained

1.4 Mathematical problems related to power factor correction mechanisms are solved

1.5 Conditions for resonance in series and parallel RLC circuit combinations are analysed

1.6 Mathematical problems involving resonance in series and parallel RLC circuit combinations are solved

1.7 Differing consequences of resonance to both RLC series and RLC parallel circuit are illustrated |
| 2 Apply complex number theory to analyse AC circuit performance | 2.1 J operator is explained

2.2 Rectangular notation of j operator is related to comparable trigonometric and polar notations

2.3 J operator is used in the addition and subtraction of phasors, applying the most appropriate notation to the solution of phasor problems involving current, voltage and impedance

2.4 Conductance, admittance and susceptance are distinguished from each other in terms of resistance, impedance and the j operator

2.5 Problems involving RL and C elements in different circuit combinations using j operator theory are solved

2.6 Power in AC circuit applications using j operator theory is calculated |
| 3 Analyse operating principles of electrical instrumentation | 3.1 Mathematical calculations are performed to demonstrate how moving coil and moving iron instruments may have their ranges changed

3.2 Mathematical calculations are performed to demonstrate how dynamometer type wattmeters may have their measuring ranges extended

3.3 Construction, operating principles and functions of <i>electrical meters</i> are outlined |

- 3.4 Principal methods and instruments used in resistance measurement are detailed
- 3.5 Resistance measurements are conducted and verified using appropriate electrical instrumentation
- 4 Analyse operating principles of DC generators**
 - 4.1 EMF equation is applied to solve problems related to DC generators
 - 4.2 Losses that may occur in DC generators are analysed
 - 4.3 Appropriate parametric relationships for DC generator losses, together with expressions for output power and efficiency are derived and associated numerical problems are solved
 - 4.4 Basic principles of DC armature winding techniques are explained
 - 4.5 Generator armature reaction is explained
 - 4.6 Expression for armature EMF is derived and applied to solve problems related to DC generators
 - 4.7 Commutator arcing and how this might be minimised or eliminated is explained
 - 4.8 Open circuit and load characteristic curves for separately excited, shunt, and compound wound DC generators are derived
- 5 Analyse operating principles of DC motors**
 - 5.1 DC torque equation is applied to solve problems related to DC motors
 - 5.2 Losses that may occur in DC motors are analysed
 - 5.3 Appropriate parametric relationships for DC motor losses, together with expressions for output power and efficiency are derived and associated numerical problems are solved
 - 5.4 Speed equation for a DC motor is derived and corresponding characteristics for different winding configurations are sketched
 - 5.5 Speed equation and characteristics of different DC motor configurations are applied to explain how DC motor speed may be controlled
 - 5.6 Reasons for armature reaction and methods of compensating for its effects are identified
 - 5.7 Why DC motors need variable starting resistors are explained

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| 6 Compare operation of synchronous motors and generators | <ul style="list-style-type: none">6.1 Marine applications of synchronous motors and generators are identified6.2 Mathematical expression for the magnitude and rotational speed of the magnetic field produced by a three-phase supply is derived6.3 Operating principle of synchronous motors is explained6.4 Operation of synchronous motors and generators are compared and contrasted6.5 Problems using phasor diagrams and mathematical expressions involving the effects of loads and excitation on synchronous motors are solved6.6 Advantages and disadvantages of AC synchronous motors and generators are analysed |
| 7 Analyse operation of single and three-phase transformers | <ul style="list-style-type: none">7.1 Basic transformation ratio and EMF equation for an ideal transformer is derived7.2 No load and on load phasor diagrams for an ideal transformer are constructed, with negligible voltage drop through its windings7.3 Causes of actual transformer losses are explained and relationships associated with the transformer equivalent circuit are derived7.4 Open circuit and short circuit tests are applied to calculate transformer efficiency and voltage regulation7.5 Problems related to the operation of auto-transformers are solved |
| 8 Analyse requirements for parallel operation of AC and DC generators | <ul style="list-style-type: none">8.1 Conditions required for shunt, series and compound wound DC generators to operate in parallel are identified8.2 Numerical problems related to parallel operation of shunt, series and compound wound DC generators are solved8.3 Conditions required for AC generators to operate in parallel are identified8.4 Numerical problems related to parallel operation of AC generators are solved |

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 advanced principles of marine electrotechnology
- Identify and apply relevant mathematical formulas and techniques to solve complex problems related to marine electrotechnology
- Identify and interpret numerical and graphical information, and perform mathematical calculations to perform tasks such as using phasor diagrams and mathematical expressions to explain the effects of loads and excitation on synchronous motors
- Identify, collate and process information required to perform complex calculations related to marine electrotechnology
- Impart knowledge and ideas through verbal, written and visual means
- Read and interpret written information needed to perform complex electrical calculations
- Use calculators to perform complex mathematical calculations

Required Knowledge:

- AC principles
- Circuits:
 - resistance
 - inductance
 - capacitance
- Complex number theory
- DC generators
- DC motors
- Difference between AC and DC
- Electrical:
 - circuits
 - current
 - power
 - safety
 - units of measurement
- Electromagnetic:
 - force
 - induction
- Electrical meters:

- energy meters
- frequency meters
- induction disc watt meters
- power factor meters
- Ohm's Law
- Operating principles of:
 - DC generators
 - DC motors
 - electrical instrumentation
- Parallel circuits
- Parallel operation of AC and DC generators
- Power factor
- Power factor correction mechanisms
- Resistance
- Single and three-phase transformers
- Synchronous motors and generators
- 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 advanced principles of marine electrotechnology can be applied
- electrical diagrams, specifications and other information required for performing advanced electrical calculations
- technical reference library with current publications on 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 advanced 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.

Electrical meters may include:

- Energy meters
- Frequency meters
- Induction disc watt meters
- Power factor meters
- Tapping point
- Turns
- Voltages

Problems may include:

Unit Sector(s)

Not applicable.

Competency Field

Marine Engineering