Australian Government

MARL040 Apply advanced principles of marine mechanics

Release: 1

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Modification History

Release 1. This is the first release of this unit of competency in the MAR Maritime Training Package.

Application

This unit involves the skills and knowledge required to apply advanced principles of marine mechanics and to perform associated calculations needed to operate and maintain marine machinery.

This unit applies to people working in the maritime industry in the capacity of:

- Engineer Class 1 (STCW Chief Engineer Unlimited)
- Engineer Class 2 (STCW Second Engineer Unlimited).

Licensing/Regulatory Information

Legislative and regulatory requirements are applicable to this unit.

- This unit is one of the requirements to obtain Australian Maritime Safety Authority (AMSA) certification as an Engineer Class 1 (STCW Chief Engineer Unlimited) or Engineer Class 2 (STCW Second Engineer Unlimited) and to meet regulatory requirements this unit must be delivered consistent with Marine Orders and with the relevant sections of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW).
- Those regulatory requirements include STCW International Maritime Organisation Organization (IMO) model course competencies and areas of knowledge, understanding and proficiency, together with the estimated total hours required for lectures and practical exercises. Teaching staff should note that timings are suggestions only and should be adapted to suit individual groups of trainees depending on their experience, ability, equipment and staff available for training.

Pre-requisite Unit

Not applicable.

Competency Field

L – Engineering

Unit Sector

Not applicable.

Elements and Performance Criteria

ELEMENTS	PERFORMANCE CRITERIA	
Elements describe the essential outcomes.	Performance criteria describe the performance needed to demonstrate achievement of the element.	
1 Apply principle of statics to determine forces in structures, connections, support systems, and trusses in two and three dimensions	**1.1**	Bows notation is applied to solve problems related to trusses
	1.2	Individual loads are computed using method of sections
	1.3	Forces in three-dimensional structures are calculated
	1.4	Principle of moments is applied to solve moments of any quantity
	1.5	Resultant of a system of co-planer forces is calculated
	1.6	Twisting moment due to engine crank mechanisms is calculated
	1.7	Moments of areas and solids are calculated
	1.8	Equilibrium of solids is explained
2 Calculate friction torque in plate and cone clutches	**2.1**	Laws of friction are applied to develop formulae, using uniform wear, to find the torque in a plate, centrifugal and cone clutch
	2.2	Laws of friction are applied to develop formulae, using uniform pressure, to find the torque in plate and cone clutches
	2.3	Power to overcome friction in plate and cone clutches using uniform wear and uniform pressure formulae is computed
	2.4	Laws of friction are applied to solve problems involving friction in inclined planes, including angle of repose
	2.5	Friction theory is applied to solve problems involving screw threads

3	**Calculate displacement, velocity and acceleration in cams, engine mechanisms and gear systems**	**3.1**	Output of epicyclic gears is calculated by applying relative velocity and acceleration theory
		3.2	Problems of linear and angular motion involving uniform acceleration and deceleration are solved
		3.3	Velocity and acceleration diagrams are applied to illustrate relative velocity and acceleration
		3.4	Inertia loads are calculated using piston velocity and acceleration equations
		3.5	Problems involving free falling bodies are solved
4	**Analyse forces and couples to balance reciprocating machinery**	**4.1**	How primary force balance is obtained is graphically illustrated
		4.2	Relationship between complete balance and dynamic balance is explained
		4.3	Reciprocating piston acceleration formula is applied to differentiate between primary and secondary forces
		4.4	Complete balance for a multicylinder reciprocating engine or machine is illustrated graphically using vector diagrams and computed analytically
		4.5	Relationship between momentum and impulse is explained
		4.6	Conservation of energy theory is applied to problems involving collision of perfectly elastic bodies
5	**Apply simple harmonic motion (SHM) principles to solve problems in free and forced vibration**	**5.1**	Differences in the terms amplitude, frequency and period are explained

		5.2	SHM equations are derived from the scotch yoke mechanism
		5.3	Equations for displacement, velocity, acceleration and frequency in SHM are developed
		5.4	Displacement, velocity, acceleration and frequency in SHM in a vibrating spring-mass system are determined
		5.5	Spring constant (k) for springs in series and parallel is calculated
		5.6	Forced vibration caused by an out-of-balance rotating mass is analysed to derive an expression for amplitude of forced vibration
		5.7	Dangers of resonance are explained
6	**Calculate stresses in components**	**6.1**	How rotational stress is generated by centrifugal force is explained
		6.2	Formula for hoop stress in a rotating ring is applied to calculate hoop stress and/or limiting speed of rotation
		6.3	Stresses in compound bars subject to axial loads and/or temperature change are determined
		6.4	Reduction in area and percentage elongation of tensile test specimens is calculated
		6.5	Stresses in composite bodies of dissimilar dimensions and dissimilar materials are calculated
		6.6	Problems involving thermal stress on components due to temperature change with free and restricted expansion are solved
7	**Apply strain energy and resilience theory to determine stresses caused by impact or suddenly applied loads**	**7.1**	Equation is derived to calculate strain energy in a deformed material
		7.2	Stress in a material due to impact or dynamic loads is determined using energy equation

		7.3	Equation to calculate stress caused by suddenly applied loads is derived
8	**Apply beam theory to solve problems**	**8.1**	Reactions of a loaded beam are calculated
		8.2	Shear force and bending moment diagrams are constructed for simply supported and cantilever beams
		8.3	Shear force and bending moment diagrams for beams with concentrated and uniformly distributed loads are calculated
		8.4	Beam equation is applied to derive stresses in beams loaded with concentrated and uniformly distributed loads
		8.5	Beam equation is applied to calculate bending stresses
		8.6	Macaulay’s method is applied to calculate beam deflection
		8.7	Deflection of cantilever and simply supported beams is calculated using standard deflection formulae for different loads
9	**Apply Euler’s formula to find buckling load of a column**	**9.1**	Effective length of a column with various end restraints is determined
		9.2	Slenderness ratio is applied to determine the strength of columns
		9.3	Relationship between slenderness ratio and buckling is explained

	9.4	How buckling load for a slender column is applied, including a factor of safety
10 Calculate stresses	**10.1**	How to combine stress formula and calculate stress with combined loading is explained
	10.2	Superposition is used to describe stress due to combined axial and bending stress
	10.3	Mohr’s Circle is employed to illustrate normal and shear stress
	10.4	Principal stress formulae are applied to explain how maximum combined normal and shear stress can be obtained
11 Apply thick and thin shell formulae	**11.1**	Tangential stress distribution caused by internal and external pressure is analysed
	11.2	Lame’s theorem is applied to describe stress in thick cylinders due to internal and external pressure
	11.3	Stress on thin-shelled pressure vessels due to internal pressure is calculated
	11.4	Formula for calculating stress on thin-shelled pressure vessels to incorporate special conditions is modified
12 Apply continuity equation to determine changes in fluid velocity	**12.1**	Conservation of energy theory is applied to calculate pressure, head and velocity of fluids flowing through orifices
	12.2	Volumetric and mass flow through a venturi meter is calculated

	12.3	Forces exerted by flowing fluids either free (jet) or contained are determined, including coefficients of velocity, contraction of area and discharge
13 Determine changes in fluid flows through pipe systems and centrifugal pumps	**13.1**	Variation of fluid pressure with depth is calculated
	13.2	Bernoulli's Theorem is used to solve problems of velocity, pressure and head in pipes and ducted systems
	13.3	Archimedes' Principle is used to solve problems related to floating vessels using real and apparent weight
	13.4	Difference between steady and unsteady flow is clarified
	13.5	Viscosity of fluids is analysed and difference between dynamic and kinematic viscosity is explained
	13.6	Significance of Reynolds number in fluid mechanics is explained
	13.7	Importance of critical Reynolds number is explained
	13.8	Flow losses in pipes and fittings are calculated
	13.9	Changes of velocity of liquids in a centrifugal pump are analysed and entry and exit vane angles are determined
14 Apply torsion theory to calculate stress	**14.1**	Twisting moment due to engine crank mechanisms is calculated

		14.2	Torsion equation is applied to solve problems involving solid and hollow shafts
		14.3	Power transmitted in shafts and coupling bolts is calculated
		14.4	Torsion equation is applied to calculate stress and deflection in a close-coiled helical spring
		14.5	Power transmitted by shafts and couplings is calculated
15	**Solve problems using principles of dynamics**	**15.1**	Centripetal force is distinguished from centrifugal force
		15.2	Relationship between centripetal and centrifugal force and mass, angular velocity and radius is clarified
		15.3	Problems are solved involving centripetal and centrifugal forces
		15.4	Centripetal acceleration is distinguished from centrifugal force
		15.5	Out-of-balance forces on co-planer systems are calculated
		15.6	Bearing reactions in rotating shafts are determined
		15.7	Radius of gyration and moment of inertion when applied to rotating bodies is explained

	15.8	Centrifugal forces in governors are calculated
	15.9	Principles of dynamics are applied to solve problems involving rotating bodies, accelerating shafts, motors and flywheels

Foundation Skills

Foundation skills essential to performance are explicit in the performance criteria of this unit of competency.

Range of Conditions

Range is restricted to essential operating conditions and any other variables essential to the work environment.

Unit Mapping Information

This unit replaces and is not equivalent to MARL016 Apply intermediate principles of marine mechanics.

This unit replaces and is equivalent to MARL020 Apply advanced principles of marine mechanics.

Links

Companion Volume implementation guide can be found in VetNet - https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=772efb7b-4cce-47fe-9bbd-ee3b1d1eb4c2