CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY – MARINE ENGINEER OFFICER

EXAMINATIONS ADMINISTERED BY THE
SCOTTISH QUALIFICATIONS AUTHORITY
ON BEHALF OF THE
MARITIME AND COASTGUARD AGENCY

STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-34 – NAVAL ARCHITECTURE

FRIDAY, 17 OCTOBER 2014

0915 - 1215 hrs

Examination paper inserts:

Notes for the guidance of candidates:

1. Non-programmable calculators may be used.
2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Materials to be supplied by examination centres:

Candidate's examination workbook
Graph paper

NAVAL ARCHITECTURE

Attempt SIX questions only

All questions carry equal marks

Marks for each part question are shown in brackets

1. A fine form vessel of length 120 m, having immersed transverse sections in the form of semi-circles, floats in sea water of density 1025 kg/m^3.

   The load waterplane is defined by half widths as shown in Table Q1.

Section	0	½	1	2	3	4	5	5½	6
Half-width (m)	1.0	3.0	5.0	7.0	8.0	7.0	4.0	2.0	0.0

Table Q1

   Calculate EACH of the following:

   (a) the load displacement; (7)

   (b) the height of the transverse metacentre above the centre of buoyancy (BM); (7)

   (c) the block coefficient (C_b). (2)

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2. A box shaped vessel of length 100 m and breadth 12 m has a full breadth midship compartment 16 m long divided by a centreline watertight bulkhead to form equal tanks port and starboard.

   The vessel is loaded to a draught of 6 m in sea water of density 1025 kg/m^3 and in this condition the KG is 3.611 m and the midship compartment has a permeability of 80%.

   The vessel is now bilged below the waterline on one side only at midships.

   Calculate the resulting angle of heel. (16)

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3. The following particulars apply to a ship of 140 m length when floating in water of density 1025 kg/m^3 at an even keel draught of 7 m:

displacement	=	14200 tonne
centre of gravity above the keel (KG)	=	8.6 m
centre of buoyancy above the keel (KB)	=	4.25 m
waterplane area	=	2049 m^2
centre of flotation from midships (LCF)	=	4.5 m aft
second moment of area of the waterplane about a transverse axis through midships	=	2.332×10^6 m^4

(a) Calculate the moment to change trim by 1 cm (MCT 1cm). (6)

(b) The ship now has the following changes of loading:

143 tonne added with its lcg 10.5 m aft of midships
80 tonne removed with its lcg at midships
60 tonne moved 40 m aft.

Calculate the new end draughts of the ship. (10)

4. A box shaped barge of length 70 m has a hull mass of 420 tonne which is evenly distributed throughout its length.

Bulkheads are located 5 m from the barge ends to form peak tanks which are empty.

The remainder of the barge is divided by two transverse bulkheads to form three holds of equal length.

These holds are loaded with a total of 1680 tonne of level stowed bulk cargo, 480 tonne of which is loaded in the centre hold and the remainder is equally distributed in the other two holds.

Draw EACH of the following curves on a base of ship length:

(a) weight and buoyancy curves; (5)

(b) load curve; (3)

(c) shear force curve; (4)

(d) bending moment curve. (4)

5. The speed of a ship is reduced by 20% when 600 nautical miles from port, thereby reducing the daily fuel consumption by 42 tonne.

The ship arrives in port with 60 tonne of fuel on board.

The fuel consumption in tonne per hour is given by the expression:

$$C = 0.14 + 0.001V^3$$

where V is the ship speed in knots.

Calculate EACH of the following:

(a) the reduced daily fuel consumption; (6)

(b) the amount of fuel on board when the speed was reduced; (4)

(c) the percentage decrease in fuel consumption for the reduced speed part of the voyage; (4)

(d) the percentage increase in time for this latter part of the voyage. (2)

6. (a) With respect to a ship's propeller, explain the term *thrust deduction*. (3)

(b) The following data were obtained during a ship's acceptance trials:

ship speed	=	15.4 knots
delivered power	=	2500 kW
effective power	=	1730 kW
thrust	=	274 kN
propeller efficiency	=	64%
apparent slip	=	5%

Calculate EACH of the following:

(i) the thrust deduction fraction; (3)

(ii) the Taylor wake fraction; (5)

(iii) the true slip; (3)

(iv) the hull efficiency. (2)

7. (a) Describe how a ship's propeller produces thrust. (4)

(b) Explain how the action of producing thrust may lead to propeller cavitation. (3)

(c) State the origin of vortex cavitation from the propeller cone. (1)

(d) Explain how a propeller blade may be eroded due to cavitation, describing the progressive nature of the damage. (8)

8. (a) Explain how a force normal to the rudder is produced when the rudder is turned to a helm angle. (3)

(b) Define the term *centre of effort* as applied to a rudder. (1)

(c) Describe how the position of *centre of effort* changes as helm angle increases. (2)

(d) Explain the term *balanced*, describing the benefits of fitting a balanced rudder. (3)

(e) Describe, with the aid of a sketch, how an angle of heel is produced due to the force on the rudder. (7)

9. (a) Describe with the aid of sketches, the influence on a statical stability curve of EACH of the following:

(i) an increase in the breadth of the ship with draught, freeboard and KG remaining constant; (4)

(ii) an increase in the freeboard of the ship with draught, breadth and KG remaining constant; (4)

(iii) an addition of large amounts of deckhouse on the upper deck with draught, breadth, freeboard and KG remaining constant. (4)

(b) A vessel sailing in calm conditions develops an appreciable angle of heel. There is no bilging.

Explain why this may have occurred, stating TWO actions that could be taken to restore the initial upright condition. (4)