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 11 APRIL 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 ship's double bottom tank is divided by an oiltight centre girder to form equal port and starboard tanks. The tanks are 16 m long and have a constant plan area defined by equidistant ordinates from the centre girder to the sides of the ship of:

   5.5 5.0 4.3 3.5 and 2.5 metres

   At a displacement of 11164 tonne, the centre of gravity is 5.733 m above the keel and both tanks are partially full of oil of density 900 kg/m^3 to a depth of 0.75 m.

   Assuming the position of the transverse metacentre to remain constant, calculate the change in effective metacentric height when all of the oil in both tanks has been consumed. (16)

2. For a ship of 5000 tonne displacement floating in water having a density of 1025 kg/m^3, the KG is 5.19 m.

   A centre double bottom tank 12.2 m in length, 6.1 m wide and 1.6 m deep is now half filled with oil of density 900 kg/m^3.

   A mass of 100 tonne is lifted from a quayside by means of the ship's lifting gear. The top of the derrick is 18 m above the keel.

   If the KM in the final condition is 7.5 m, calculate EACH of the following:

   (a) the final effective metacentric height; (13)

   (b) the maximum outreach of the derrick if the angle of heel is not to exceed 5°. (3)

3. The hydrostatic particulars given in Table Q3 are for a ship of length 150 m when floating in water of density 1025 kg/m^3 .

Draught (m)	Displacement (tonne)	MCT 1 cm (tm)	LCB from midships (m)	LCF from midships (m)
7.5	18200	216.5	0.85 forward	2.44 aft
7.0	16800	214.0	1.07 forward	2.24 aft

Table Q3

The ship floats in water of density 1015 kg/m^3 with draughts of 7.6 m aft and 6.8 m forward.

Calculate EACH of the following:

(a) the displacement; (8)

(b) the longitudinal position of the ship's centre of gravity. (8)

4. A ship of 8000 tonne displacement has a rudder area of 22 m^2. The ship has a KM of 6.7 m, KG of 6.1 m and the centre of lateral resistance is 3.8 m above the keel. The maximum rudder angle is 35 degrees and the centroid of the rudder is 2.3 m above the keel.

The force generated normal to the plane of the rudder is given by:

$F_n = 580 A v^2 \sin \alpha$

Where: A = rudder area, v = ship speed in m/s, α = rudder helm angle

Calculate EACH of the following, when the vessel is travelling at 20 knots:

(a) the angle and direction of heel due to the rudder force only, if it is put hard over to port; (8)

(b) the angle and direction of heel due to the combination of centrifugal force and rudder force when the rudder is hard over to port and the vessel turns in a circle of 800 m diameter. (8)

5. A ship has a length of 130 m and floats in sea water of density 1025 kg/m^3. A model of this ship has a length of 5 m and a wetted surface area of 6 m^2.

The model has a total resistance of 45 N when towed at 1.85 m/s in fresh water of density 1000 kg/m^3.

(a) Using the data below, calculate EACH of the following:

(i) the ratio of residuary resistance to total resistance for the model; (5)

(ii) the ratio of residuary resistance to total resistance for the ship at the corresponding speed. (8)

(b) State why the two ratios should be different. (3)

Note: *The frictional coefficient for the model in fresh water is 1.694*
The frictional coefficient for the ship in sea water is 1.418
Speed in m/s with the speed index (n) for ship and model 1.825

6. The following data were obtained during acceptance trials for a ship of 11650 tonne displacement:

ship speed = 16 knots;

torque delivered to the propeller = 340 kNm;

propeller thrust = 465 kN;

propeller speed = 1.85 rev/s;

effective power = 2900 kW;

propeller efficiency = 67%;

apparent slip ratio = 0.06;

transmission losses = 3%.

Calculate EACH of the following:

(a) the pitch of the propeller; (3)

(b) the Taylor wake fraction; (4)

(c) the real slip ratio; (1)

(d) the thrust deduction fraction; (3)

(e) the quasi-propulsive coefficient; (2)

(f) the Admiralty Coefficient based upon shaft power. (3)

7. With reference to *brittle fracture* of a ship's hull:

(a) describe the occurrence and characteristics of brittle fracture; (6)

(b) explain the term *transition temperature*; (1)

(c) state the conditions which would make brittle fracture more likely to occur; (4)

(d) describe how a ship's hull material will resist brittle fracture in critical areas. (5)

8. (a) Explain how noise is transmitted to some position distant from the original source of that noise. (3)

(b) State SIX possible origins of noise commonly found on board ships. (6)

(c) Describe the design considerations and constructional techniques which may be used in ships to reduce the transmission of noise and to diminish noise in a given space. (7)

9. (a) State the benefits to the shipowner of a ship being classified. (4)

(b) Explain the role of the Classification Society in EACH of the following stages of a ship’s life:

(i) design; (4)

(ii) building; (4)

(iii) operation. (4)