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, 18 OCTOBER 2013

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 of length 140 m displaces 13492 tonne when floating in sea water of density 1025 kg/m^3. The centre of gravity is 4.0 m above the centre of buoyancy and the waterplane is defined by the following equidistant half-ordinates given in Table Q1:

Station	AP	1	2	3	4	5	6	7	8	9	FP
Half-ordinates (m)	2.5	6.4	8.5	9.4	9.6	9.6	9.5	8.4	6.5	3.2	0

Table Q1

Calculate EACH of the following:

(a) the area of the waterplane; (3)

(b) the position of the centroid of the waterplane from midships; (3)

(c) the second moment of area of the waterplane about a transverse axis through the centroid; (5)

(d) the moment to change trim one centimetre (MCT 1cm). (5)

2. Table Q2 gives values of righting levers (GZ) relating to a ship of 10500 tonne displacement in a particular load condition:

Angle of heel (degrees)	0	15	30	45	60	75	90
GZ (m)	0	0.47	1.20	1.50	1.34	0.74	- 0.22

Table Q2

In the above condition the ship has 315 tonne of fuel stored in a double bottom tank which has to be emptied for survey. This oil is transferred to a wing deep tank, through a transverse distance of 5 m and a vertical height of 4 m.

(a) Draw the amended curve of statical stability, neglecting the effects of free surface. (12)

(b) From the curve drawn in Q2(a) determine EACH of the following:

(i) the angle to which the ship will list; (1)

(ii) the range of stability. (1)

(c) Calculate the righting moment at an angle of 25°. (2)

3. A vessel of constant rectangular section 80 m long and 12 m wide has a KG of 3.93 m and floats on an even keel draught of 5 m in water of density 1025 kg/m^3. The vessel is fitted with a transverse watertight bulkhead 10 m from the forward end.

The compartment forward of the transverse bulkhead, which has a permeability of 75%, is now damaged and laid open to the sea.

Calculate the new end draughts of the vessel. (16)

4. The hull of a box shaped vessel is 80 m long and has a mass of 800 tonne uniformly distributed over its length.

Two holds extending over the forward and aft quarter lengths of the vessel each have 240 tonne of cargo stowed uniformly over their lengths.

Machinery of mass 200 tonne extends uniformly over the middle quarter length of the vessel.

(a) Using graph paper, draw EACH of the following curves for the vessel:

(i) load/metre; (6)

(ii) shearing force. (6)

(b) Determine the maximum bending moment. (4)

5. A ship consumes an average of 70 tonne of fuel per day on main engines at a speed of 17 knots.

The fuel consumption for auxiliary purposes is 8 tonne per day.

When 800 nautical miles from port it is found that only 140 tonne of fuel remains on board and this will be insufficient to reach port at the normal speed.

Determine, using a graphical solution, the speed at which the ship should travel to complete the voyage with 20 tonne of fuel remaining. (16)

6. (a) The residuary resistance of a 1/25 scale model of a ship is 6.35 N when tested at 1.543 m/s in fresh water of density 1000 kg/m^3.

The frictional resistance of the ship at 12 knots in sea water of density 1025 kg/m^3 is 145 kN. Frictional resistance can be assumed to vary with speed to the power 1.825.

Calculate the effective power (naked) for the ship at the speed *corresponding* to the model test. (8)

(b) The following additional data apply to the ship operating in service at the corresponding speed calculated in Q6(a) with a propeller having a pitch of 4.6 m.

appendage and weather allowance	=	22%
quasi-propulsive coefficient (QPC)	=	0.7
propeller speed	=	1.75 revs/s
Taylor wake fraction	=	0.32
propeller thrust	=	565 kN

Calculate EACH of the following:

(i) the torque delivered to the propeller; (3)

(ii) the propeller efficiency; (3)

(iii) the real slip ratio. (2)

7. (a) Explain the meaning of the term *propeller cavitation*. (6)

(b) Describe, with reasons, the areas on a propeller blade that are more susceptible to cavitation. (5)

(c) State how *face cavitation* may occur. (2)

(d) Explain why cavitation on a propeller is not steady and the consequence of this. (3)

8. (a) The I.M.O. Bulk Chemical Codes divide chemical carriers into three types according to the potential degree of hazard of the cargo, in the event that sustainable damage is incurred. Explain how the location of the cargo fulfils these requirements. (8)

(b) State FOUR types of compatibility problem associated with the carriage of chemical cargoes and explain how EACH of the problems listed is minimised. (8)

9. With reference to the resistance of a ship:

(a) define speed-length ratio; (1)

(b) explain the term *dynamic similarity*; (3)

(c) state Froude's Law of Comparison for residuary resistance; (3)

(d) explain the difference between effective power and thrust power; (2)

(e) explain why the thrust of a propeller needs to be greater than the total resistance of a ship; (3)

(f) describe, with reasons, the typical shape of a curve of residuary resistance against a base of ship speed. (4)