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 78 (as amended) CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-34 – NAVAL ARCHITECTURE

FRIDAY, 15 JULY 2016

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 vessel of SWATH (small waterplane area twin hull) design, has the following hydrostatic particulars when floating in water of density 1025 kg/m^3.

Displacement	=	1390 tonne
centre of buoyancy above the keel (KB)	=	2.744 m
centre of gravity above the keel (KG)	=	6.837 m

The distance between the centrelines of each hull is 12 m and the half breadths of each hull, measured at equal intervals along the 72 m length of waterplane, are as shown in Table Q1.

Station	0	1	2	3	4	5	6	7	8
½ Breadth (m)	0	0.6	1.0	1.3	1.4	1.3	1.0	0.6	0

Table Q1

Calculate the transverse metacentric height of the vessel in the above condition. (16)

2. A box shaped vessel is 100 m long, 20 m wide and floats at a draught of 5 m.

Due to a collision, a full width compartment 25 m long situated at midships, is bilged.

Calculate EACH of the following, using the *lost buoyancy* method:

(a) the permeability of the compartment if the final draught in the bilged condition is 5.85 m; (6)

(b) the change in transverse metacentric height due to bilging this compartment. (10)

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3. The following data relate to a ship of length 220 m and breadth 36 m when fully loaded to an even keel draught of 12.4 m in sea water of density 1025 kg/m^3.

Displacement	=	85000 tonne
Waterplane area coefficient (C_w)	=	0.82
Longitudinal centre of flotation from midships (LCF)	=	2 m aft
Longitudinal metacentric height (GM_L)	=	242 m

The ship may be considered to be wall sided in the region of the waterline.

Prior to the final loading operation, the draughts are 12.65 m aft and 11.00 m forward and the following two holds are available for the remaining cargo to be loaded:

No 1 hold with lcg 60 m forward of midships
No 4 hold with lcg 35 m aft of midships

Calculate the masses of cargo to be loaded into the two holds to bring the ship to its fully loaded even keel draught. (16)

4. A box barge of 88 m length, 12 m breadth and 6 m depth has a hull mass of 600 tonne evenly distributed throughout its length.

Bulkheads located 4 m from the barge ends, form peak tanks which may be used for ballast. The remainder of the barge length is divided by 4 transverse bulkheads into 5 holds of equal length. The holds are full of bulk cargo having a stowage rate of 1.6 m^3/t.

The peak tanks are empty.

(a) Calculate the midship bending moment during discharge when both end holds are half empty. (8)

(b) Calculate the minimum depth of sea water ballast of density 1025 kg/m^3, which must be added to the peak tanks to allow complete discharge of the end holds if the midship sagging bending moment is to be restricted to a maximum of 50 MNm. (8)

5. The following data in Table Q5 were obtained during progressive speed trials on a ship of 11400 tonne displacement.

Ship speed (knots)	12	13	14	15	16
Shaft power (kW)	1960	2455	3040	3720	4505

Table Q5

Under normal service conditions, the ship operates within this range and has an Admiralty Coefficient of 458, based upon shaft power.

(a) (i) Determine the normal service speed of the ship. (6)

(ii) In a fouled hull condition, with the service shaft power being maintained, the ship's speed is found to have decreased by 6% from normal. Assuming that the specific fuel consumption remains constant at 190 g/kWhr, determine the increase in fuel consumed over a distance of 2500 nautical miles. (5)

(b) A geometrically similar ship having a displacement of 13500 tonne is to be built.

Determine the shaft power required for this ship at a speed of 15.5 knots. (5)

6. The wetted surface area of a container ship is 7135 m^2.

When travelling at service speed, the shaft power required is 22500 kW with residuary resistance 25% of the total resistance and specific fuel consumption is 0.22 kg/kWhr.

Propulsive coefficient, based upon shaft power is 0.6.

Friction coefficient in sea water is 1.411 when speed is in m/s
Speed index (n) is 1.825.

(a) Calculate the service speed of the ship. (10)

(b) To conserve fuel the ship speed is reduced by 10%, the daily fuel consumption is then found to be 100 tonne.

The propulsive coefficient may be assumed constant at 0.6.

Calculate the percentage increase in specific fuel consumption when running at the reduced speed. (6)

7. (a) Define the term *open water efficiency* as applied to a ship's propeller. (1)

(b) Describe the losses that affect the open water efficiency of the propeller. (6)

(c) State the causes of ship wake. (3)

(d) Explain the propeller-hull interactions that contribute to the hull efficiency. (6)

8. State the problems associated with the carriage of EACH of the following products, describing the precautions necessary for the safe transportation of EACH:

(a) grain; (4)

(b) timber on deck; (4)

(c) iron ore; (4)

(d) concentrates (finely grained minerals) containing a proportion of moisture. (4)

9. With reference to the testing of a ship model in a towing tank:

(a) define the term *corresponding speed*; (2)

(b) state Froude's Law of Comparison; (2)

(c) explain how the effective power of a ship can be estimated from the model test. (12)