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, 14 DECEMBER 2012

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q2

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 168 m, floating in sea water of density 1025 kg/m^3, has a displacement of 30750 tonne.

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

Station	AP	½	1	2	3	4	5	6	7	7½	FP
Half-widths (m)	2	7	10	12	13	13	12	10	6	3	0

Table Q1

The following particulars are also available:

centre of buoyancy above the keel (KB) = 4.154 m
centre of gravity above the keel (KG) = 7.865 m
centre of lateral resistance above the keel = 4.665 m

The following tanks contain slack liquid as indicated:

- rectangular fresh water tank 10 m long and 8 m wide;
- rectangular fuel oil tank, containing fuel of relative density 0.875, 10 m long and 12 m wide, divided into two equal tanks by an oiltight longitudinal bulkhead.

Calculate the angle to which the ship will heel when turning on a circular course of 400 m diameter at a speed of 16 knots. (16)

2. The righting moment for a ship in a particular condition of loading is known to be 44000 tonne metres at a displacement of 27500 tonne when heeled to an angle of 30° from upright.

   Using the cross curves of stability provided on Worksheet Q2:

   (a) determine the KG of the ship for the condition of loading; (5)

   (b) draw, on graph paper, a curve of statical stability for the load condition; (8)

   (c) From the statical stability curve drawn in Q2(b), determine EACH of the following:

      (i) the range of stability; (1)

      (ii) the righting moment at 20° heel. (2)

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3. A ship of length 130 m is loaded as shown in Table Q3(a).

Item	Mass (tonne)	lcg from midships (m)
lightship	3500	1.85 aft
cargo	8100	3.7 forward
oil fuel	800	6.5 aft
stores	25	13.8 forward
fresh water	25	19.4 forward
crew & effects	10	midships

Table Q3(a)

Table Q3(b) is an extract from the ship's hydrostatic particulars and linear interpolation may be used to obtain data at intermediate draughts.

Draught (m)	Displacement (tonne)	LCB from midships (m)	MCT 1cm (tm)	LCF from midships (m)
8.0	14000	1.8 forward	160	1.52 aft
7.0	11800	2.3 forward	145	1.22 aft

Table Q3(b)

Determine the end draughts of the ship after loading has been completed. (16)

4. A box shaped barge of uniform construction is 80 m long, 10 m wide and has a light displacement of 720 tonne. It is divided into three compartments by two transverse watertight bulkheads so that the end compartments are of equal length. The barge is loaded to a draught of 6 m in water of density 1025 kg/m^3 with cargo evenly distributed over the two end compartments.
The empty midship compartment, extending the full width and depth of the barge is now bilged and the draught increases to 8 m.

(a) Determine the length of the midship compartment. (3)

(b) For the original intact condition:

(i) draw curves of weight and buoyancy distribution; (5)

(ii) determine the longitudinal still water bending moment at midships. (4)

(c) Determine the longitudinal still water bending moment at midships for the final bilged condition. (4)

5. A ship of length 140 m and breadth of 22 m floats at a draught of 9 m in sea water of density 1025 kg/m^3. In this condition the block coefficient (C_b) is 0.72.

A geometrically similar model, 5 m in length, gives a total resistance of 30.85 N when tested at a speed of 1.55 m/s in fresh water of 1000 kg/m^3 at a temperature of 12°C.

The following data are also available:

Ship correlation factor 1.22
Temperature correction ±0.43% per °C
Frictional coefficient for the model in water of density 1000 kg/m^3 at 15°C is 1.694
Frictional coefficient for the ship in water of density 1025 kg/m^3 at 15°C is 1.415
Speed in m/s with index (n) for ship and model 1.825
Wetted surface area (S) $= 2.57\ \sqrt{\Delta L}$ (m^2)

Calculate the effective power of the ship at the speed corresponding to the model when the ship is travelling in sea water of density 1025 kg/m^3 at a temperature of 15°C. (16)

6. The following data apply to a ship travelling at 16 knots:

propeller speed	=	1.8 rev/sec
propeller pitch ratio	=	0.9
real slip ratio	=	0.33
Taylor wake fraction	=	0.30
torque delivered to the propeller	=	420 kNm
propeller thrust	=	560 kN
quasi-propulsive coefficient (QPC)	=	0.70
transmission losses	=	3%
fuel consumption per day	=	24.5 tonne

Calculate EACH of the following:

(a) the apparent slip ratio; (4)

(b) the propeller diameter; (2)

(c) the propeller efficiency; (4)

(d) the thrust deduction fraction; (4)

(e) the specific fuel consumption. (2)

7. (a) Describe how cavitation occurs on a ship's propeller, explaining how it is more likely to occur as draught reduces and sea water temperature increases. (8)

(b) Describe FOUR types of propeller cavitation. (4)

(c) State FOUR detrimental effects of propeller cavitation. (4)

8. (a) State the FOUR cargo systems that may be used for the carriage of liquefied gases. (4)

(b) (i) Describe, with the aid of a sketch, a membrane tank containment system suitable for the carriage of liquefied natural gas (LNG). (8)

(ii) Sketch the barrier and insulation system for the membrane tank described in Q8(b)(i). (4)

9. With reference to watertight sub-division of a ship:

(a) describe the purpose of watertight bulkheads; (2)

(b) define EACH of the following terms:

(i) bulkhead deck; (1)

(ii) margin line; (1)

(iii) floodable length; (1)

(iv) permissible length; (1)

(v) factor of sub-division. (1)

(c) state the criterion that decides whether or not a ship has foundered; (1)

(d) state the TWO variables that the factor of sub-division depends upon; (2)

(e) describe the stability requirements with respect to metacentric height and angle of list for a vessel that has sustained *reasonable* damage. (6)