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, 19 DECEMBER 2014

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. The load waterplane of a ship 120 m long, floating in sea water of density 1025 kg/m^3, is defined by the following half-breadths given in Table Q1.

Section	AP	½	1	2	3	4	5	6	7	7½	FP
Half- breadth (m)	1.6	3.6	5.6	7.4	8.1	8.2	8.1	6.9	4.0	2.0	0

Table Q1

The following particulars are obtained from the ship's hydrostatic curves:

Displacement	=	8450 tonne
centre of buoyancy above the keel (KB)	=	3.21 m
moment to change trim by one centimetre	=	101.5 tm

Calculate EACH of the following:

(a) the position of the longitudinal centre of flotation (LCF) from midships; (6)

(b) the second moment of area of the waterplane about a transverse axis through the centroid; (6)

(c) the height of the ship's centre of gravity above the keel. (4)

2. An inclining test carried out on a passenger vessel at a displacement of 8725 tonne in water of density 1012 kg/m^3 resulted in an angle of heel of 1.5° when an inclining mass of 10 tonne was moved 15 m transversely across the deck.

To obtain the lightship condition for the vessel, corrections for the following masses are required:

40 tonne to be removed at Kg 9.2 m
65 tonne to be added at Kg 10.15 m

The following masses in Table Q2 are to be added to give the load condition:

Item	**Mass (tonne)**	**Kg (m)**
Passengers & effects	60	10.5
Stores	190	8.1
Oil fuel	1600	3.42
Fresh water	400	1.8

Table Q2

In the above condition, free surfaces of liquid are present in one rectangular tank 8m long and 6m wide containing fresh water of density 1000 kg/m^3 and in four rectangular tanks each 10 m long and 8 m wide containing oil fuel of density 950 kg/m^3.

Using the hydrostatic curves provided in Worksheet Q2, determine EACH of the following:

(a) the lightship KG; (7)

(b) the final mean draught in sea water; (2)

(c) the final effective metacentric height. (7)

3. A ship 150 m in length displaces 14000 tonne and floats at draughts of 6.25 m forward and 6.6 m aft. The longitudinal metacentric height is 165 m, the centre of flotation is 1.8 m aft of midships and the TPC is 22.

The vessel is required to enter dock with a draught aft of 6.5 m and a trim of 1 m by the stern.

Calculate EACH of the following:

(a) the mass of ballast to be discharged; (6)

(b) the distance of its centre of gravity from midships. (10)

4. The force acting normal to the centreline plane of a rudder is given by the expression:

$$F_n = 15.5\ A\ v^2\ \alpha \quad \text{newtons}$$

Where: A = rudder area (m^2)
v = ship speed (m/s)
α = rudder helm angle (degrees)

A ship travelling at a speed of 20 knots has a rudder configuration as shown in Fig Q4. The centre of effort for areas A_1 and A_2 are 32% of the width from their respective leading edges. The rudder angle is limited to 35° from the ship's centreline.

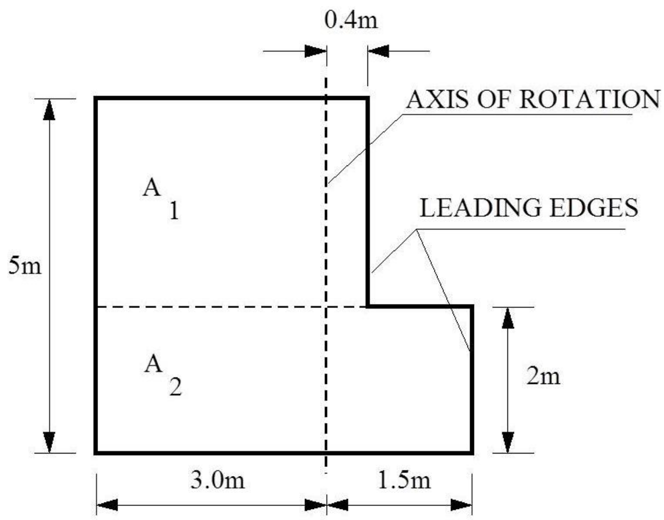

Fig. Q4

Calculate EACH of the following:

(a) the diameter of the rudder stock required for a maximum allowable stress of 77 MN/m^2; (12)

(b) the drag component of the rudder force when the rudder is put hard over at full speed. (4)

5. The results in Table Q5 were obtained from resistance tests on a ship model 6 m in length having a wetted surface area of 7.5 m^2 in fresh water of 1000 kg/m^3 at a temperature of 13°C.

Model speed (m/s)	1.6	1.7	1.8	1.9
Total resistance (N)	40.0	46.2	55.8	70.5

Table Q5

The following particulars are also available:

Ship correlation factor 1.22
Temperature correction ±0.43% per °C

Calculate the effective power of a similar ship 160 m long travelling at a speed of 17.5 knots in sea water of density 1025 kg/m^3 at a temperature of 15°C. (16)

Note: frictional coefficient for the model in water of density 1000 kg/m^3 at 15°C is 1.655
frictional coefficient for the ship in water of density 1025 kg/m^3 at 15°C is 1.410
speed in m/s with index (n) for ship and model 1.825

6. A ship 145 m long and 23 m beam displaces 19690 tonne when floating at a draught of 8 m in sea water of density 1025 kg/m^3.

The following data are given for the service speed of 16 knots:

effective power (naked)	=	3450 kW
appendage and weather allowance	=	20%
quasi-propulsive coefficient	=	0.71
thrust deduction fraction	=	0.21
transmission losses	=	3%
specific fuel consumption	=	0.205 kg/kW hr

The Taylor wake fraction is obtained from:

$$w_t = 0.5\ C_b - 0.05$$

(a) Calculate EACH of the following at the service speed:

(i) the delivered power; (2)

(ii) the thrust power; (7)

(iii) the fuel consumption per day. (3)

(b) Calculate the maximum speed at which the ship must travel to complete a voyage of 3000 nautical miles, with only 200 tonne of fuel on board. (4)

7. (a) State the benefits of aluminium alloy as a construction material for a ship, describing its application. (6)

(b) State the disadvantages of using aluminium alloy. (4)

(c) Describe, with the aid of a sketch, how the problem of galvanic corrosion between a steel hull and aluminium alloy superstructure is overcome. (6)

8. (a) Explain the procedure required to produce weight, buoyancy and load curves for a ship assumed to be floating in still water, stating any relevant features of the curves. (8)

(b) Describe how shear force and bending moment curves are produced from a load diagram, explaining how the features of EACH curve are connected. (8)

9. With reference to crude oil carriers:

(a) Explain EACH of the following terms:

(i) segregated ballast tanks; (3)

(ii) clean ballast tanks; (3)

(iii) protective locations. (2)

(b) (i) Explain the crude oil washing (COW) system for cargo tank cleaning; (4)

(ii) State the advantages of crude oil washing. (4)