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, 8 APRIL 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 RO-RO ferry of length 120 m has a displacement of 12800 tonne in sea water of density 1025 kg/m^3 with BM = 4.6 m.

   The breadth of the ship at the waterline, between sections 3 and 7 is constant at 20 m.

   To increase stability, *sponsons*, 2.7 m deep and of constant plan area are to be fitted as shown in Fig Q1. For the new condition there is no change in draught and the load waterline is at mid-depth of the sponson.

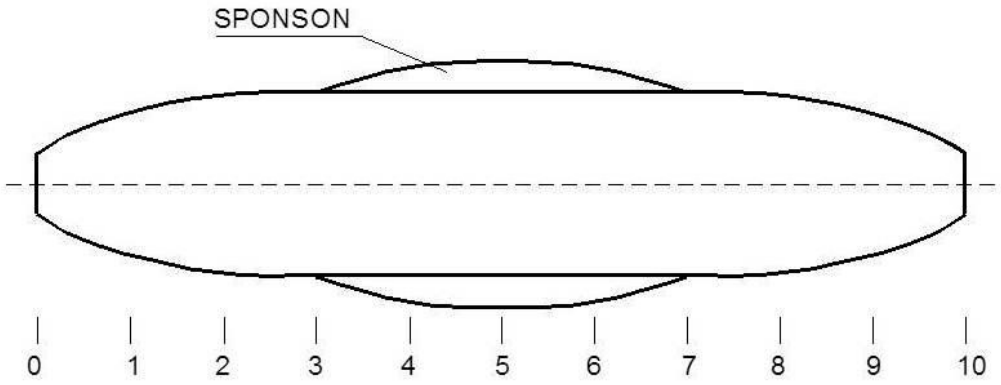

Fig Q1

The sponsons extend over the midship length between sections 3 and 7, with sponson widths as shown in Table Q1.

Section	3	4	5	6	7
Sponson width (m)	0	1.8	2.7	1.8	0

Table Q1

Calculate the increase in BM due to the sponsons. (16)

2. A ship of length 150 m and breadth 20 m floats upright at a draught of 7.5 m in sea water of density 1025 kg/m^3 and the height of the centre of gravity above the keel (KG) is 5.388 m.

Further hydrostatic data for this condition are as follows:

centre of buoyancy above the keel (KB)	=	3.956 m
height of metacentre above the keel (KM)	=	7.014 m
waterplane area coefficient (C_w)	=	0.82
block coefficient (C_b)	=	0.72

In the above condition there is an empty rectangular wing tank 16 m long, 5 m wide and 5 m deep, adjacent to the hull and directly above a double bottom tank 1.2 m deep.

Assuming the ship to be wall sided over the change of draught, calculate the angle to which the ship will heel when the tank is completely filled with fresh water of density 1000 kg/m^3. (16)

3. A ship of length 160 m has the following hydrostatic particulars when floating at an even keel draught in sea water of density 1025 kg/m^3.

waterplane area	=	1951 m^2
displacement	=	15058 tonne
longitudinal metacentric height (GM_L)	=	170 m
centre of flotation from midships (LCF)	=	1.5 m aft

The ship in the above condition grounds on a rock which may be assumed to be at a point 55 m forward of midships and settles such that the end draughts are 6.65 m aft and 5.52 m forward.

Calculate the original draught of the ship. (16)

4. A rectangular oil barge of light displacement 300 tonne is 60 m long and 10 m wide. The barge is divided by four transverse bulkheads into five compartments of equal length.

When compartments 2 and 4 contain equal quantities of oil and the other compartments are empty, the barge floats at a draught of 3 m in fresh water of density 1000 kg/m^3.

(a) Draw EACH of the following curves on a base of barge length:

(i) curve of loads; (4)

(ii) curve of shearing forces; (4)

(iii) curve of bending moments. (5)

(b) State the magnitude and position of the maximum bending moment. (3)

5. A ship model of length 5 m has a wetted surface area of 4.2 m^2 and is tested in water of density 1000 kg/m^3. The test results give the values of residuary resistance for a range of model speeds as shown in Table Q5.

Model speed (m/s)	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80
Residuary resistance (N)	3.00	3.35	3.85	4.60	5.80	7.40	9.15	10.50	11.40

Table Q5

(a) (i) Plot a curve of residuary resistance against speed for the model. (2)

(ii) Comment on the shape of this curve. (2)

(b) For a geometrically similar ship of length 125 m operating in sea water of density 1025 kg/m^3 at service speed of 16.0 knots, the following data is applicable:

appendage allowance	=	7%
weather allowance	=	14%
quasi-propulsive coefficient (QPC)	=	0.7
transmission losses	=	3%

Determine the shaft power required for the ship at its service speed. (12)

Note: The frictional coefficient for the ship in sea water is 1.42 with speed in m/s and index(n) for ship and model is 1.825.

6. A ship 145 m long, 24.5 m beam, displaces 24910 tonne when floating at a draught of 9.5 m in sea water of density 1025 kg/m^3.

The propeller has a diameter of 6.0 m and a pitch ratio of 0.95.

With the propeller operating at 1.75 revs/sec, the following results were recorded:

propeller thrust	=	1300 kN
real slip	=	35%
propeller efficiency	=	67%
transmission losses	=	3%
fuel consumption per day	=	63 tonne

Calculate EACH of the following:

(a) the ship speed; (6)

(b) the apparent slip; (2)

(c) the specific fuel consumption; (4)

(d) the mass of fuel required to travel 3500 nautical miles at a speed of 17.5 knots including a reserve of 10%. (4)

Note: Wake fraction (W_T) = 0.5 C_b - 0.05

7. (a) Explain the term *composite material*. (3)

(b) Describe the composition of GRP, outlining its advantages for use on lifeboats. (7)

(c) Describe the disadvantages of GRP when compared to low carbon (mild) steel. (6)

8. With reference to the carriage by sea of hazardous chemicals in bulk:

(a) explain how the protection of the internal structure is achieved; (8)

(b) outline the safety precautions to be observed by crew members to ensure personal safety. (8)

9. With reference to the tonnage measurement of a ship:

(a) explain the difference between *Gross Tonnage* and *Net Tonnage*. (4)

(b) explain EACH of the following terms:

(i) enclosed spaces; (2)

(ii) excluded spaces. (4)

(c) State the functions of the *Tonnage Certificate*, giving examples of its use in the day-to-day operations of ships. (6)