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, 20 JULY 2012

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q3

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	=	2820 tonne
centre of buoyancy above the keel (KB)	=	2.655 m
centre of gravity above the keel (KG)	=	5.875 m

The distance between the centrelines of each hull is 18 m and the half breadths of each hull, measured at equal intervals along the 66 m length of waterplane are as shown in Table Q1.

Station	0	1	2	3	4	5	6
½ Breadth (m)	0	0.7	1.0	1.1	1.0	0.7	0

Table Q1

Calculate the transverse metacentric height of the vessel. (16)

2. A vessel of 10000 tonne displacement floats at a draught of 7.2 m in sea water of density 1025 kg/m^3.

Further hydrostatic data are:

centre of buoyancy above the keel (KB)	=	3.844 m
transverse metacentre above the keel (KM)	=	7.186 m
tonne per centimetre immersion (TPC)	=	18

The vessel is unstable and heels to an angle of 8°.

To restore positive stability, ballast of 540 tonne is now loaded at a Kg of 0.5 m.

Calculate EACH of the following for the final condition:

(a) the transverse metacentric height; (13)

(b) the righting moment when the vessel is heeled to an angle of 15°. (3)

Note: *The vessel may be considered wall-sided between the limits of draught, hence:*

$$GZ = \sin\theta\,(GM + \tfrac{1}{2}\,BM\,\tan^2\theta)$$

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3. A ship 140 m long floats at draughts of 6.8 m aft and 4.4 m forward when floating in river water of density 1012 kg/m^3.

Using the hydrostatic curves provided in Worksheet Q3, determine EACH of the following:

(a) the displacement; (8)

(b) the longitudinal position of the centre of gravity. (8)

4. A single screw ship with a service speed of 15 knots is fitted with a rectangular rudder, 5.5 m deep and 3.5 m wide with the axis of rotation 0.4 m aft of the leading edge. At a rudder angle of 35°, the centre of effort is 32% of the rudder width from the leading edge.

The force on the rudder normal to the plane of the rudder is given by the expression:

$$F_n = 577\, A\, v^2 \sin \alpha \quad \text{newtons}$$

where:

A = rudder area (m^2)

v = ship speed (m/s)

α = rudder angle (degrees)

The maximum stress in the rudder stock is to be limited to 70 MN/m^2.

Calculate EACH of the following for a rudder helm angle of 35 degrees:

(a) the minimum diameter of the rudder stock for ahead running; (9)

(b) the speed of the ship, when running astern, at which the maximum stress level would be reached. (7)

5. The data in Table Q5 were obtained during progressive speed trials on a ship of 12550 tonne displacement.

Ship speed (knots)	13	14	15	16	17
Shaft power (kW)	2733	3362	4097	4946	5922

Table Q5

Under normal service conditions, the ship operates within this range and has an Admiralty Coefficient of 446, 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 8% from normal.

Determine the increase in fuel consumed over a distance of 3000 nautical miles, assuming that the specific fuel consumption remains constant at 195 g/kWhr. (5)

(b) A geometrically similar ship is to be built having a displacement of 14500 tonne and ship speed 16.5 knots.

Calculate the new shaft power. (5)

6. The wetted surface area of a container ship is 5946 m^2.

When travelling at the service speed, the effective power required is 11250 kW, with residuary resistance 26% of the total resistance and specific fuel consumption is 0.22 kg/kW hr.

The friction coefficient in sea water is 1.432 when speed is in m/s with speed index (n) 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 83 tonne. Propulsive coefficient based upon shaft power may be assumed constant at 0.6.

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

7. (a) Explain how a propeller blade may be eroded due to cavitation, describing the progressive nature of the damage. (8)

(b) Outline the design features that may be considered to minimise cavitation. (8)

8. (a) Explain the role of the Classification Society in the design and building stages of a ship. (6)

(b) Explain the classification notation system. (4)

(c) Explain the nature of the surveys required during the operation stages of the ship in order that the ship retains its classification. (6)

9. (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)

(This Worksheet must be returned with your answer book)

Name ....

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Centre......................................

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HYDROSTATIC CURVES