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, 17 JULY 2015

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 ship 160 m in length floats in sea water of density 1025 kg/m^3. At the load draught, the immersed sectional areas of the main body of the ship are as given in Table Q1A:

Station	AP	½	1	2	3	4	5	6	7	8	9	9½	FP
Immersed section areas (m^2)	5	19	39	76	93	101	107	106	97	67	29	13	7

Table Q1A

Details of hull appendages are as given in Table Q1B.

Item	Volume (m^3)	Centre from midships (m)
Transom stern	16	83 aft
Rudder	7	81 aft
Bulbous bow	12	82 forward

Table Q1B

Calculate EACH of the following:

(a) the displacement; (8)

(b) the longitudinal position of the centre of buoyancy from midships. (8)

2. A ship of 10000 tonne displacement floats in sea water of density 1025 kg/m^3 at a draught of 6 m.

A rectangular tank 10 m long and 8 m wide is partially full of oil fuel of density 900 kg/m^3.

In this condition, the KG of the ship is 6.25 m.

Other hydrostatic data for the above condition are:

Centre of buoyancy above the keel (KB)	= 3.325 m
Transverse metacentre above the centre of buoyancy (BM)	= 4.865 m
tonnes per centimetre immersion (TPC)	= 20.5

A rectangular tank 12 m long 10 m wide and 6 m deep, with its base 1 m above the keel, is now filled to a depth of 5 m with sea water ballast.

Calculate the change in effective metacentric height. (16)

3. A box shaped vessel 100 m long and 10 m wide floats at an even keel draught of 4 m in sea water of density 1025 kg/m^3 with a KG of 5 m.

A full width, empty compartment has its after bulkhead 20 m forward of midships and its forward bulkhead 30 m forward of midships.

Calculate the end draughts of the vessel if this compartment is bilged. (16)

4. A uniformly constructed box shaped vessel of length 80 m and breadth 12 m has an even keel draught of 2 m when floating in the light condition in sea water of density 1025 kg/m^3.

The vessel has five holds of equal length and is to be loaded with 7000 tonne of cargo, with equal quantities in EACH of the centre and end holds, and the balance equally distributed in No. 2 and No. 4 holds.

The cargo in all holds will be trimmed level.

Calculate EACH of the following:

(a) the maximum amount to be loaded in the centre and end holds in order that a maximum hogging bending moment amidships of 4000 tm will not be exceeded; (12)

(b) the resulting shear force at each of the bulkheads. (4)

5. The following values of effective power (naked hull) refer to a ship which is to have a service speed of 16.25 knots.

Speed (knots)	15	15.5	16	16.5	17.0
ep_n (kW)	6320	6890	7820	9220	11000

The following data also apply:

appendage allowance = 7%
weather allowance = 14%
quasi propulsive coefficient = 0.71
transmission losses = 3%
engine mechanical efficiency = 86%
ratio of service indicated power to installed machinery indicated power = 0.9

Determine EACH of the following:

(a) the indicated power of the engine to be installed; (8)

(b) the speed obtained if all the available power of the engine is used:

(i) when the ship is running on acceptance trial in calm conditions; (4)

(ii) when operating under actual service conditions. (4)

6. A model propeller of 0.3 m diameter and 0.25 m pitch is tested in fresh water of density 1000 kg/m^3.

At a speed of advance of 1.8 m/s and a rotational speed of 10.0 revs/s, the torque is 12 Nm and the thrust developed is 260 N.

A geometrically similar ship's propeller 5.4 m in diameter, is operating in water of density 1025 kg/m^3 at corresponding linear and rotational speeds.

(a) For the ship's propeller calculate EACH of the following:

(i) revolutions per second; (1)

(ii) speed of advance; (1)

(iii) real slip; (3)

(iv) delivered power; (3)

(v) efficiency. (4)

(b) Calculate the hull efficiency when the propeller is operating on a vessel at a Taylor-Wake fraction of 0.26 and a thrust deduction fraction of 0.22. (4)

Note: For similar propellers at corresponding speeds, it can be assumed;
Linear speed is proportional to (diameter)^{½}
Rotational speed is proportional to (diameter)$^{-½}$
Thrust is proportional to (diameter)^{3}
Torque is proportional to (diameter)^{4}

7. (a) With reference to ship hull vibration, explain, with the aid of diagrams, EACH of the following terms:

(i) two-node vertical mode; (4)

(ii) three-node horizontal mode. (4)

(b) State how hull vibration can be minimised in vessels during the design stage and on vessels already built. (8)

8. With reference to the inclining experiment:

(a) state the purpose of the experiment and when the experiment should be performed during the life of a ship; (2)

(b) explain the procedure immediately prior to the experiment; (4)

(c) describe the procedure for the experiment; (4)

(d) explain SIX precautions to ensure acceptable accuracy of results. (6)

9. (a) State how discontinuities are created in the longitudinal structure of a ship's upper deck. (2)

(b) Explain how a discontinuity may lead to a structural failure. (5)

(c) State THREE points of discontinuity in a ship's structure, describing how the possible problems of structural failure are overcome. (9)