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, 13 DECEMBER 2013

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. At a draught of 1.2 m in sea water of density 1025 kg/m^3 the displacement of a ship is 1100 tonne and the height of the centre of buoyancy above the keel (KB) is 0.72 m.

Values of tonne per centimetre immersion (TPC) in sea water, for a range of draughts, are given in Table Q1:

Draught (m)	1.2	1.8	2.4	3.6	4.8	6.0	7.2
TPC	12.4	13.2	13.8	14.7	15.4	15.9	16.2

Table Q1

(a) Calculate EACH of the following for a draught of 7.2 m in sea water:

(i) the displacement; (4)

(ii) the height of the centre of buoyancy above the keel (KB). (6)

(b) At a draught of 7.2 m, the height of the longitudinal metacentre above the keel (KM_L) is 135 m and the second moment of area of the waterplane about a transverse axis through midships is 1289670 m^4.

The centre of flotation is aft of midships.

Calculate the distance of the centre of flotation (LCF) from midships. (6)

2. A ship of 5000 tonne displacement floats at a mean draught of 7 m when in sea water of density 1025 kg/m^3, but is unstable and has an *angle of loll.*

Hydrostatic particulars for the ship in the upright condition at the above displacement are as follows:

centre of buoyancy above the keel (KB)	=	3.706 m
height of transverse metacentre above the keel (KM)	=	5.926 m
tonne per centimetre immersion (TPC)	=	10.0

To achieve a satisfactory stable condition with a metacentric height of 400 mm, a load of 500 tonne is added to the ship on the centreline at a Kg of 2.5 m.

Calculate, for the original unstable condition, EACH of the following:

(a) the height of the original centre of gravity above the keel (KG); (12)

(b) the angle of loll. (4)

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

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

3. A ship of length 130 m has a light displacement of 4800 tonne with the longitudinal centre of gravity 0.5 m aft of midships.

Loading now takes place as given in Table Q3:

Load	**Mass (tonne)**	**lcg from midships (m)**
cargo	3400	38.0 forward
cargo	4000	30.0 aft
oil fuel	640	14.5 forward
fresh water	100	55.0 forward
stores etc.	60	35.0 aft

Table Q3

Using Worksheet Q3, extract the relevant data from the hydrostatic curves and hence determine the final end draughts of the vessel in sea water of density 1025 kg/m^3. (16)

4. A box shaped vessel is 80 m long, 12 m wide and floats at a draught of 4m.

A full width midship compartment 15 m long is bilged and this results in the draught increasing to 4.75 m.

Calculate EACH of the following, using the lost buoyancy method:

(a) the permeability of the compartment; (4)

(b) the change in metacentric height due to bilging the compartment. (12)

5. The following data applies to a ship operating on a particular voyage with a propeller of 6 m diameter having a pitch ratio of 0.9:

propeller speed	=	1.85 revs/s
real slip	=	33%
apparent slip	=	6%
shaft power	=	11000 kW
specific fuel consumption	=	0.205 kg/kW hr

Calculate EACH of the following:

(a) the ship speed in knots; (3)

(b) the Taylor wake fraction; (3)

(c) the reduced speed at which the ship should travel in order to reduce the voyage consumption by 30%; (2)

(d) the voyage distance if the voyage takes 30 hours longer at the reduced speed; (4)

(e) the amount of fuel required for the voyage at the reduced speed. (4)

6. Fig Q6 shows the results of progressive speed trials on a ship at a load displacement of 22350 tonne in sea water of density 1025 kg/m^3 with a wetted surface area of 4860 m.

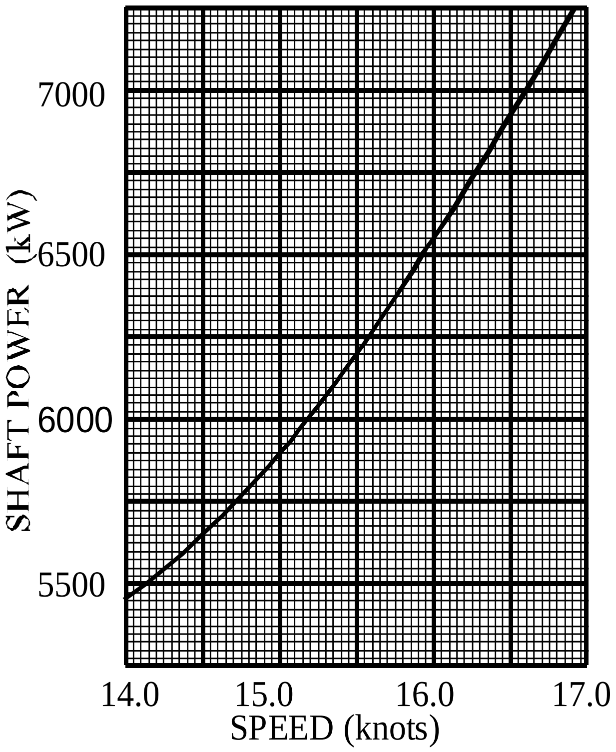

Fig Q6

Using the data given below, calculate the shaft power required to achieve a service speed of 17 knots with a geometrically similar ship having a load displacement of 29245 tonne in sea water. (16)

propulsive coefficient based upon shaft power for both trial and service conditions = 0.68
allowance for appendages and weather in trial condition = 8%
allowance for appendages and weather in service condition = 20%

Note: *frictional coefficient for the 22350 tonne ship in sea water is 1.410*
frictional coefficient for the 29245 tonne ship in sea water is 1.406
speed is in m/s with index (n) = 1.825

7. Lloyds Grade A low carbon (mild) steel normally constitutes the majority of the structure of a modern merchant ship, but alternatives to mild steel that may be used include:

- higher tensile steel
- Lloyds Grade E steel
- alloy steels containing nickel and manganese
- stainless steel
- aluminium alloy

Evaluate the use of these alternatives, stating the types of vessel with which they are used. (16)

8. (a) Describe TWO functions that trials data fulfils on a newly built ship, other than for satisfying owners of ship performance at sea. (4)

(b) State the TWO types of speed trial carried out. (2)

(c) State the requirements of a measured mile trials course. (4)

(d) List the conditions to be satisfied on a speed trials run. (4)

(e) Explain why trials runs are carried out in double runs. (2)

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 and information on the certificate. (6)