JULY 2011

NAVAL ARCHITECTURE 1 JULY 11

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/m³. 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 (m²)	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 (m³)	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)

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2. A ship has a lightship displacement of 9500 tonne and the height of centre of gravity above the keel (KG) is 8.54 m.

Loading now takes place as detailed in Table Q2.

Item	Mass (tonne)	Kg (m)
cargo	21750	9.18
oil Fuel	920	2.55
fresh water	250	4.9
stores etc	80	12.3

Table Q2

In this loaded condition, the height of the transverse metacentre above the keel (KM) is 10.38 m.

(a) Using the cross curves of stability provided in Worksheet Q2, construct a curve of statical stability for the loaded vessel. (12)

(b) Using the curve derived in Q2(a), determine the dynamical stability of the vessel up to an angle of 40°. (4)

3. A ship of 125 m in length has the following particulars when floating in sea water of density 1025 kg/m³.

displacement	=	11923 tonne
draught aft	=	7.244 m
draught forward	=	6.844 m
longitudinal metacentric height (GM_L)	=	130 m
centre of flotation from midships (LCF)	=	2.5 m aft
tonnes per centimetre immersion (TPC)	=	18.5

Two tanks, each containing a substantial quantity of water ballast, are situated with their centres of gravity 25 m aft of midships and 50 m forward of midships.

The vessel is required to enter dock with draught aft 7 m and a trim of 0.6 m by the stern.

Calculate the amount of ballast to be discharged from each tank. (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/m³.

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

5. The following results in Table Q5 were obtained from resistance tests on a ship model 6 m in length having a wetted surface area of 7 m² in fresh water of 1000 kg/m³ at a temperature of 12°C.

Speed (m/s)	1.50	1.75	2.00	2.25
Total resistance (N)	37.5	44.0	55.8	76.3

Table Q5

Ship correlation factor 1.18
Temperature correction ±0.43% per °C

Calculate the effective power of a similar ship 140 m long travelling at a speed of 18 knots in sea water of density 1025 kg/m³ at a temperature of 15°C. (16)

Note:
The frictional coefficient for the model in water of density 1000 kg/m³ at 15°C is 1.655
The fractional coefficient for the ship in water of density 1025 kg/m³ at 15° C is 1.415
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/m³.

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) Define the term *open water efficiency* as applied to a ships propeller. (1)

(b) Describe the losses that affect the open water efficiency of the propeller. (6)

(c) State the causes of ship wake. (3)

(d) Explain the propeller-hull interactions that contribute to the hull efficiency. (6)

8. (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)

9. With reference to the inclining experiment:

(a) (i) state the purpose of the experiment; (1)

(ii) state when the experiment should be performed during the life of a ship. (1)

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

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

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