March 2010

NAVAL ARCHITECTURE I MARCH 10

Attempt SIX questions only

All questions carry equal marks

Marks for each part question are shown in brackets

1. A ship of length 120m displaces 11750 tonne when floating in sea water of density 1025kg/m³. The centre of gravity is 2.5m above the centre of buoyancy and the waterplane is defined by the following equidistant half breadths given in Table Q1:

Station	AP	1	2	3	4	5	6	7	FP
Half-breadth (m)	3.3	6.8	7.6	8.1	8.1	8.0	6.6	2.8	0

Table Q1

Calculate EACH of the following:

(a) the area of the waterplane; (3)

(b) the position of the centroid of the waterplane from midships; (3)

(c) the second moment of area of the waterplane about a transverse axis through the centroid; (5)

(d) the moment to change trim one centimetre (MCT 1cm). (5)

2. A ship of breadth 20m has a displacement of 13500 tonne and a metacentric height of 1.962m when floating upright in sea water of density 1025kg/m³.

A rectangular oil fuel bunker 4m long, 20m wide and 10m deep is divided on the centreline by a longitudinal oiltight bulkhead to form two equal tanks which are both full of fuel oil of density 900kg/m³.

An adjoining rectangular cargo hold of length 18m and breadth 20m is empty.

The transverse bulkhead separating the starboard oil fuel bunker and the hold ruptures at the bottom so that liquid flows freely between the bunker and hold.

Calculate the angle to which the ship will heel. (16)

3. A ship of length 130m is loaded as shown in Table Q3(a).

Item	Mass (tonne)	Lcg from midships (m)
lightship	3500	1.85 aft
cargo	8100	3.7 forward
oil fuel	800	6.5 aft
stores	25	13.8 forward
fresh water	25	19.4 forward
crew & effects	10	midships

Table Q3(a)

The following hydrostatic data in Table Q3(b) can be assumed to have a linear relationship between the draughts shown.

Draught (m)	**Displacement** (tonne)	**LCB** from midships (m)	**MCT 1cm** (tm)	**LCF** from midships (m)
8.0	14000	1.8 forward	160	1.52 aft
7.0	11800	2.3 forward	145	1.22 aft

Table Q3(b)

Calculate the final end draughts. (16)

4. A box shaped vessel is 80m long, 12m wide and floats at a draught of 4m.
A full width midship compartment 15m long is bilged and this results in the draught increasing to 4.75m.

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 refer to two geometrically similar ships:

Ship	Length (m)	Wetted surface area (m^2)	Displacement (tonne)	Friction coefficient f (sea water)	Speed index n
Ship A	122	2680	8775	1.4275	1.825
Ship B			16250	1.4213	1.825

Fig Q5 shows the results of a progressive speed trial for ship A.

Calculate the shaft power required for ship B travelling at a speed of 18.5 knots, given that the propulsive coefficient for both ships is 0.6. (16)

Note: friction coefficient to be used with speed in m/s

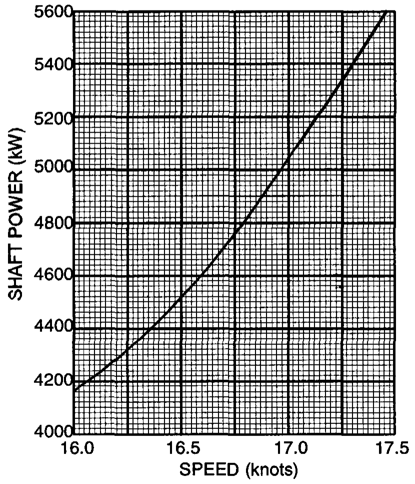

Fig Q5

6. The following data applies to a ship operating on a particular voyage with a propeller of 6m diameter having a pitch ratio of 0.95.

propeller speed	1.8 rev/sec
real slip	34%
apparent slip	7%
shaft power	10500 kW
specific fuel consumption	0.210 kg/kW hr

Calculate EACH of the following:

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

(b) the Taylor wake fraction; (4)

(c) the reduced speed at which the ship should travel in order to halve the voyage consumption; (2)

(d) the voyage distance if the voyage takes 3 days longer at the reduced speed; (4)

(e) the amount of fuel required for the voyage at the reduced speed. (3)

7. (a) Describe how the variable wake in which a propeller works may lead to vibration problems at the aft end. (4)

(b) Explain how a highly skewed propeller can reduce the problem of propeller excited vibration. (4)

(c) Discuss the validity of the following statement: (4)

"The propeller design parameters that maximise efficiency will tend to lead to vibration problems."

(d) Describe how the after end structure is constructed to resist vibration. (4)

8. (a) Define *critical temperature* and *boiling point* and hence show how some liquefied gases may be transported fully pressurised, whilst others need to be carried fully refrigerated. (6)

(b) State the basic differences in construction of fully pressurised and fully refrigerated systems for the carriage of liquefied gas at sea. (5)

(c) Compare the membrane tank and independent tank systems of construction. (5)

9. (a) Sketch transverse cross sections of a ship, showing the forces acting when the ship is lying at a large angle of heel due to EACH of the following, indicating the positions of the initial and final centres of buoyancy and gravity and the initial position of the transverse metacentre:

(i) an external force (wind or wave); (2)

(ii) a transverse shift of cargo; (2)

(iii) initial instability. (2)

(b) Sketch and label typical statical stability curves for EACH of the following ship loading conditions:

(i) the ship's centre of gravity on the centreline and the ship having a positive metacentric height; (4)

(ii) the ship's centre of gravity off the centreline and the ship having a positive metacentric height; (3)

(iii) the ship's centre of gravity on the centreline and the ship having a negative metacentric height. (3)