INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Time : 2 hours

Date of Examination 21 Feb 2012 (AN)
Full Marks : 30

Spring Semester : 2011-2012
3rd Year BTech

Subject No : NA31002
Subject name : **Marine Design**

No. of students : 44

Instructions: ***Answer all questions. Marks are given in brackets***

Q1. Using axial momentum theory, show that for an ideal fluid the propeller open water efficiency is given by

$$\eta_i = \frac{2}{1+\sqrt{1+C_{TL}}},$$

where $C_{TL} = \dfrac{T}{0.5\,\rho\,A_O V_A^2}$, T = propeller thrust, A_O = actuator disc area,. V_A = free stream velocity and ρ = density of water.

Explain the significance of the above equation in the selection of the propulsor and stern geometry at the preliminary design stage.

(7)

Q2. What are the considerations for the stern design of a single screw ocean going ship?

Design the stern portion of a container ship using following information:

$\alpha = 0.20*D$, $\beta = 0.30*D$, $\gamma\gamma = 0.30*D$, $\delta = 0.12*D$ (see Fig. 1 for details)

Rudder area (movable + fixed) = 54.5 sq. m, Rudder aspect ratio 1.80, the rudder is tapered from top to bottom in the ratio 1.2, Rudder stock centerline = 35% of rudder chord from the leading edge.

Propeller shaft diameter (mm) = $100 * K * \sqrt[3]{\left(\frac{H}{R}\left(\frac{c_1}{U+c_2}\right)\right)}$

H (engine MCR power) = 40,000 kW, R (engine MCR rpm) = 94 rpm, K = 1.05, c_1 = 560 N/mm^2, c_2 = 160 N/mm^2, U = 600 N/mm^2

Thickness of shaft boss opening at the aft end = 90.0 mm

Design propeller diameter (D) = 8.0 m, P/D at 0.70R = 0.9967, C/D at 0.70R = 0.36.

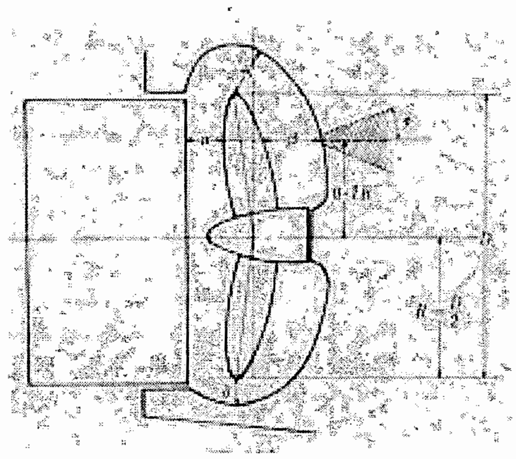

Fig. 1 Recommended propeller hull clearances.

(6)

Q3. The typical layout of an oil tanker and a container ship is shown in Fig. 2 a and 2 b. Assume that the ships do not have sinkage, trim during heeling. What is the down flooding angle for each one of the ship. Explain why the area under GZ curve till down flooding angle is important.

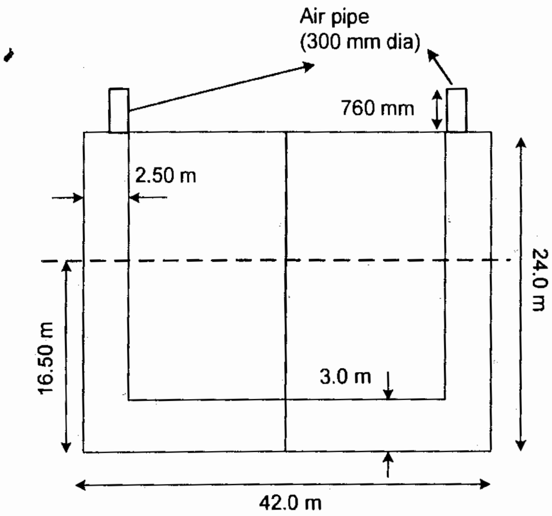

Fig. 2 a Layout of an oil tanker. Not to scale

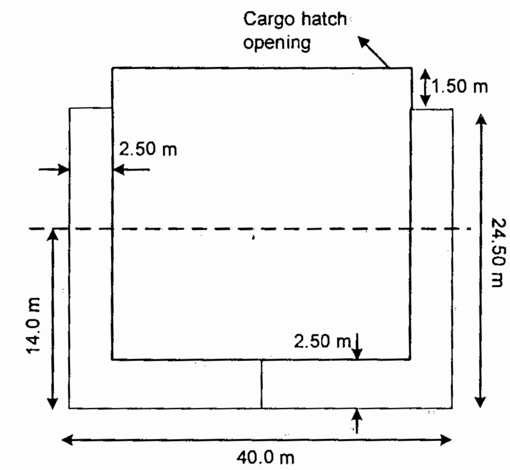

Fig. 2 b Layout of a container ship. Not to scale

(3)

Q4. The details of an already built general cargo ship are as follows:

Deadweight at design draught = 16000 tonnes; Service speed = 15.0 knots;

$L_{PP} = 142.5\,m$; $B_{mld} = 20.5\,m$; $D_{mld} = 13.2\,m$; $T(design) = 9.0\,m$;

Main Engine is a medium speed diesel engine with reduction gear box of MCR (P_B) = 6000 kW for service speed of 15.0 knots;

Steel weight = 3650 tonnes; Outfit weight) = 750 tonnes; Machinery weight = 410 tonnes

Initial GM_T = 0.5 m;

Find out the main dimensions of another ship to carry a deadweight of 15000 tonnes at a service speed of 15 knots having a similar form and similar structural, machinery and outfit arrangements except the following:

- It is to have a slow speed engine having MCR of 6000 kW as main propulsion unit which weighs 150 tonnes more than that of the given ship.
- It is to have an extra twin Gemini crane weighing 100 tonnes.
- It is to have a maximum draught of 8.5 metres only
- Its initial metacentric height should be at least 0.5 metres assuming that the vertical centres of gravity and buoyancy of either ship are given by $0.63 \times D$ and $0.65 \times T$ respectively.

(All assumptions while carrying out the design should be justified and stated clearly)

(14)

***********This paper consists of one page only************