

# INDIAN MARITIME UNIVERSITY

(A Central University, Government of India)

## END SEMESTER EXAMINATION JUNE 2022

**Programme:** B.Tech (Marine Engineering)      **Semester:** VI

**Subject Name:** Naval Architecture II      **Subject Code:** UG11T3605

**Date:** 08.06.2022      **Maximum Marks:** 70

**Time:** 03 Hours      **Pass Marks:** 35

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### **Part A – Q.No.1;10 MCQs (10 X 01 Mark)**

**(All questions are compulsory)**

- (i) The static condition or the bollard pull condition is referred as when
- A. the Thrust and Torque Coefficients are maximum with  $J=0$
  - B. the propeller is revolving about its own axis without advancing through the water
  - C. the 100% slip condition occurs
  - D. All of the options provided
- (ii) Following are the reasons for placing rudders at aft:
- I. As the pivoting point lies towards the aft end of the ship, hence the leverage of the stern rudder will be more than that of a bow rudder.
  - II. The stern rudders gain from the effect of the propeller race.
  - III. Bow rudders increases drag of the ship, as it disturbs the laminar flow to the ship.
- A. Reasons I and II are correct but III is incorrect
  - B. Reasons I and III are correct but II is incorrect
  - C. Reasons II and III are correct but I is incorrect
  - D. All reasons I, II, and III are correct
- (iii) For the Kinetic similarity between the ship and the model requires
- A. ratio of any two dimensions in the model must be equal to the ratio of corresponding dimensions in the ship.
  - B. ratio of velocity components in the flow around the model must be equal to the ratio of corresponding components around the ship.
  - C. ratio of Force components acting at a point on the model must be equal to the ratio of corresponding force components acting at the corresponding point on the ship
  - D. None of the options provided.
- (iv) The performance of heavily loaded propellers can be improved by using
- A. Shrouded or Ducted Propeller
  - B. Controllable Pitch Propeller
  - C. Tandem Propellers
  - D. Water jet Propulsion

- (v) If the ship's rudder is placed on hard starboard and the ship is taking steady turn, on which side will it heel?
- Port
  - Starboard
  - It will not heel, as it is taking a steady turn
  - Cannot say
- (vi) To increase the period of roll and to reduce the stiffness of ship, the following action is suggested
- Cargo should be loaded transversely away from centre-line of the ship
  - Cargo should be loaded above the centre of gravity of the ship
  - Both A & B are suggested
  - A is suggested but B is not recommended.
- (vii) For the rudders behind fin or skeg or behind the fixed structure, the horizontal distance of the center of pressure from the leading edge is equal to
- $0.35 \times$  Chord distance from the Leading edge of the rudder
  - $0.31 \times$  Chord distance from the Leading edge of the rudder
  - $0.195 + 0.305 \sin \alpha$  distance from the Leading edge of the rudder
  - None of the options provided
- (viii) With respect to the total resistance of the ship, the following statements are made.
- At low speeds viscous resistance dominates.
  - At high speeds, the total resistance curve turns upward dramatically as wave-making resistance begins to dominate
- Statement I is correct and II is incorrect
  - Statement II is correct and I is incorrect
  - Both the statements are incorrect
  - Both the statements are correct
- (ix) The Significant wave height is defined as
- Average wave height in a wave record
  - Average apparent height of the two third highest waves in a wave record
  - Average apparent height of the one third lowest waves in a wave record
  - Average apparent height of the one third highest waves in a wave record
- (x) The viscosity of the liquid surrounding the ship causes the
- formation of the boundary layer around it
  - formation of the eddies behind it, if it is not streamlined properly
  - formation of wake behind it, if it is not streamlined properly
  - All of the options provided.

**Part B – Q.No.2;5 Short Questions (05 X 02 Marks)**

**(All questions are compulsory)**

- (i) Briefly explain the phenomena of the relative velocity of water past the rudder ( $V_R$ ) and write down the formulae used for any two cases of the rudder and propeller configuration.
- (ii) Briefly explain the concept of Spectral density of the wave.
- (iii) Briefly explain the concept of Kinematic similarity for the model and ship's propeller and prove that Advance Coefficients for model and ship's propeller remains same.
- (iv) Mention any four assumptions made in the derivation of Axial Momentum Theory.
- (v) Using the concept of Fuel Coefficient, prove that Total fuel consumption for a journey of distance D is proportional to  $\Delta^{2/3} * V^2 * D$

**Part C – 7 Long Questions-Answer Any 5 (05 X 10 Marks)**

3.(a) A ship with the length of 120m & 5100 tonnes displacement is to be designed for a speed of 20knots. For this, model test in the towing tank is proposed using a model of length 3m. Neglecting the variation in densities, determine the displacement of the model and speed at which the model should be towed to conduct the model test.

**(05 Marks)**

(b) With the help of neat diagram explain the phenomena of hull-propeller interaction and describe three major effects on the performance of the propeller and the ship when the propeller is fitted behind the ship.

**(05 Marks)**

4. Describe the step by step procedure of ITTC 1957 method of model testing in the towing tank to estimate the Effective power ( $P_{ES}$ ) of the ship from the total resistance of the model ( $R_{TM}$ ) estimated. Write down the formulae and explain each and every term in each formula used in each and every step.

**(10 Marks)**

5.(a) With the help of neat sketch describe the phenomena of cavitation of the propeller. Moreover, explain the term cavitation number.

**(04 Marks)**

(b) A ship is propelled by a turbine with shaft power of 12500 kW at 6000 rpm and is moving at a speed of 16 knots. It has a Gearbox with 50:1 reduction in gearing. The Propulsion train has the Shafting and Gearing efficiency of 94% generating the propeller thrust of 800kN. Assume the wake fraction and thrust deduction fraction are 0.24 and 0.2 respectively. Determine the delivered power, the thrust power and the effective power, as well as the propeller torque.

**(06 Marks)**

6. Based on the following data of the propeller, calculate the Torque, Delivered Power, Thrust, Thrust Power, Speed of Advance and the efficiency of the propeller.

Diameter = 4.88m,  $K_Q = 0.015$ ,  $K_T = 0.097$ ,  $J = 0.633$ ,  $N = 120$

**(10 Marks)**

7. A vessel of 6000 tonnes displacement has a transverse metacentric height  $GM_T = 0.6$  m. The period of roll ( $T_R$ ) in still water is found to be 18 seconds. Find the new period of roll when a mass of 150 tonnes is discharged from a position 10 m above the centre of gravity of the ship.

**(10 Marks)**

8. A centerline rudder placed in a twin-screw ship, is rectangular in shape, 4m wide and 3m deep. It is pivoted at its leading edge with the help of a stern frame ahead of it for full depth. Assume the rudder force normal to the mean chord line is given by

$$N = 577 A_P V_R^2 \sin \delta_R \text{ Newton}$$

Where,  $A_P$  is projected area of the rudder in  $m^2$ ,  $V_R$  is relative velocity of water past the rudder in m/s and  $\delta_R$  is the rudder angle in degrees. Estimate the torque acting on the rudder stock when it is placed at 35 degrees. The ship's speed is 18 knots. Also calculate the diameter of rudder stock if the maximum stress allowed is 77.22MPa. The center of pressure of rudder is 2m below the bearing.

**(10 Marks)**

9.(a) With the help of neat sketch, prove that the angle of heel during a steady turn of the ship is given by

**(05 Marks)**

$$\tan \phi = \frac{V^2}{Rg} * \frac{GH}{GM}$$

(b) With the help neat sketch, describe the Modified Z-Manoeuvre Test. State the reasons for developing the Modified Z-Manoeuvre Test when the usual Z-Manoeuvre Test was in use. **(05 Marks)**