

**Indian Maritime University**  
**(A Central University, Govt of India)**  
**Supplementary Examinations – March/April 2025**  
**Programme Name: B Tech (ME)**  
**Semester: VI**  
**Subject Code: UG11T4605**  
**Subject Name: Naval Architecture 2**

Date: 28.04.2025

Max Marks: 70

Duration: 03 Hrs

Pass Marks: 35

General Instructions

- (i) All Sections (A, B & C) are to be attempted.
- (ii) Options, if any, are specified in respective section.

**Section A**

**Answer all questions. Each question carries 1 mark**

Select the most appropriate answer from the given choices for each of the following questions.

1. With regard to the initial phase of turn of a ship, just after the rudder is put over to port, which of the following statements are correct:

Statement I: ship sways a little to the starboard

Statement II: ship develops a small angle of heel to the starboard

Statement III: ship slows down slightly

- (a) all are correct
- (b) I & II are correct
- (c) II & III are correct
- (d) I & III are correct

2. For the given rudder force, which of the following rudders will have the least twisting moment on the rudder stock?

- (a) balanced
- (b) unbalanced
- (c) semi-balanced
- (d) L-shaped

3. In the  $20^0/20^0$  zig-zag test, the amount by which the ship's heading exceeds the  $20^0$  deviation before reducing is called as the\_\_\_\_\_.

- (a) drift angle
- (b) angle of rudder deflection
- (c) overshoot angle
- (d) angle of heel

4.  $GM_T$  remaining constant, which of the following correctly describes the relation between the natural time period of roll ' $T_R$ ' and transverse radius of gyration ' $k_T$ '?

- (a)  $T_R$  increases with increasing  $k_T$       (b)  $T_R$  decreases with increasing  $k_T$   
(c)  $T_R$  increases with decreasing  $k_T$       (d)  $T_R$  does not depend on  $k_T$

5. With respect to ship movement in waves, a sea that is coming directly on the bow with the crests almost perpendicular to the ship's centreline is called\_\_\_\_\_.

- (a) Beam Sea      (b) Head Sea  
(c) Bow Sea      (d) Following Sea

6. During the steady turn of a ship, the angle between the heading of the ship (fore-and-aft centreline) and the tangent to the circular path of the Centre of Gravity of the ship is defined as the \_\_\_\_\_.

- (a) angle of helm      (b) angle of incidence  
(c) drift angle      (d) angle of heel during steady turn

7. The factor used to calculate true effective power of a ship (fitted with all appendages and in normal sea conditions) from the effective power of naked hull (from model test results) is called as\_\_\_\_\_.

- (a) thrust deduction factor      (b) ship correlation factor  
(c) service margin      (d) engine load margin

8. Which one of the following is the function of bilge keel

- (a) Backbone of the ship      (b) Resist docking loads  
(c) Roll stabilisation      (d) part of bilge and ballast system

9. A propeller that revolves in the anti-clockwise direction (when viewed from aft) when propelling the ship forward is called a\_\_\_\_\_.

- (a) inward turning propeller      (b) right hand propeller  
(c) outward turning propeller      (d) left hand propeller

10. Which resistance affects the surface water craft, such as boats and ships and reflects the energy required to push the water out of the way of the hull

- (a) Frictional resistance      (b) Wave- making resistance  
(c) Residual resistance      (d) Wave breaking resistance

### **Section B**

(Each question carries 02 Marks. Answer all questions)

11. Distinguish between a fully balanced and an unbalanced rudder with regard to the positioning of the stock and torque on the stock at 35 deg deflection.

12. Explain significant wave height of a sea spectrum. What is its significance?

13. State the factors on which frictional resistance of a ship depends.
14. Define hull efficiency. How is it related to the Taylor wake fraction ( $w$ ) and thrust deduction fraction ( $t$ )?
15. What is the purpose of anti-roll tanks in ships?

### Section C

(Each question carries 10 Marks. Answer any 05)

16. A spade rudder on the middle line behind twin screws has an area of  $13.9 \text{ m}^2$ . The ship speed is 15 knots. Determine the normal force on the rudder at an angle of helm of 35 degrees. The centre of pressure of a rudder is 0.21 m abaft the axis of rotation and 1.22 m below the bearing. Determine the diameter of the rudder stock using equivalent torque method, if the maximum allowable stress is 77.2 MPa. Use Haslar formula for normal force on rudder  $F_N = 15.5 \times A \times V^2 \times \theta$  Newtons
- 17.(a) Sketch a typical turning circle, giving the path of the CG of the ship from the point when the helm is first put over up to the point when the ship has turned through  $360^\circ$ . Show on your diagram what is meant by Advance, Transfer, Tactical Diameter and Drift Angle. (6 marks)
- 17.(b) State Froude's law of comparison. A ship of length 100 meters has a speed of 15 knots. Determine the corresponding speed of its model of length 4 m (4 marks)
18. A 6.5 m model of a ship has a wetted surface area of  $8 \text{ m}^2$ , and when towed in fresh water at 3.25 knots, has a total resistance of 44 N. Calculate the effective power of the ship, 130 m long, at its corresponding speed given that  $SCF = 1.15$ , the speed index,  $n = 1.825$  and Froude's frictional resistance coefficient in SW,  $f = 0.417 + \frac{0.773}{L+2.862}$ .
19. (a) State the important assumptions of Axial Momentum Theory and the important inferences that can be drawn regarding the following propeller efficiency (5 Marks)
19. (b) List the various parameters recorded during an open water test for a model propeller and draw a neat labeled diagram of typical open water characteristics curves. (5 Marks)
20. A ship travelling at 15.5 knots has a propeller of 5.5 m pitch turning at 95 rev/min. The thrust of the propeller is 380 kN and the delivered power 3540 kW. If the real slip is 20% and the thrust deduction factor 0.198, calculate the Thrust Power, QPC and the wake fraction.
- 21.(a) Describe the Controllable Pitch Propeller along with its advantages compared to FPP. (5 Marks)
- 21.(b) A propeller 6m diameter has a pitch ratio of 0.9, BAR 0.48 and when turning at 110 rev/min, has a real slip of 25% and wake fraction 0.30. If the

propeller delivers a thrust of 300 kN and the propeller efficiency is 0.65, calculate:

- a) blade area
- b) ship speed
- c) thrust power
- d) delivered power
- e) torque.

(5 Marks)

22.(a) Describe the formation of a fully developed sea due to wind generated waves stating the factors on which the height and length of waves depends.

(6 Marks)

22.(b) A ship has a length of 97.5 m; breadth 10.65 m; draught 3.35 m; transverse metacentric height = 0.76 m; longitudinal metacentric height = 110 m;  $K_T = 3.65$  m;  $K_L = 24.4$  m;  $C_B = 0.54$ ;  $C_{WP} = 0.70$ . Determine the natural periods of: (i) rolling with no added virtual mass of water (ii) pitching with no added virtual mass of water, and (iii) heaving with added virtual mass of water equal to ship's mass

(4 Marks)