

Indian Maritime University
(A Central University, Govt of India)
End Semester Examinations – December 2023
Programme Name: M Tech (NAOE)
Semester: I
Subject Code: PG11E2101
Subject Name: Ship Hydrodynamics (R&P)

Date: 15-12-2023

Max Marks: 60

Duration: 03 Hrs

Pass Marks: 30

General Instructions

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

Section A:

10 MCQs of 01 Mark Each = 10 Marks

1. The primary purpose of fitting a bulbous bow is to reduce _____ resistance.
2. State whether the statement is true or false "Frictional resistance increases when draught increase". _____
3. Left hand propeller rotate in _____ direction when producing ahead thrust.
4. In the expression $R_t = T(1-t)$, 't' represents _____
5. Cavitation at a particular location of the propeller indicates region of _____
6. Identify the propeller material that is most preferred for tugs
 - (a) Cast iron
 - (b) Cast steel
 - (c) Copper alloys
 - (d) Stainless steel
7. State whether the statement is true/false: "ship self-propulsion point on the model is at $F \neq 0$ ". _____
8. In dock trials, the propeller runs at _____ percent slip.
9. The aim of contra-rotating propellers is to reduce _____ losses in slipstream.
10. Tulin blade sections are employed in _____ propeller.

Section B:

5 out of 7 Questions of 8 Marks Each = 40 Marks

11.

- a) Describe how the Kelvin wave pattern explains the nature of the waves generated by a ship. How do the "humps and hollows" in the wave resistance curve of a ship occur? (5 marks)
- b) What is the effect of shallow water on the resistance of a ship?(3 marks)

12.

- a) Explain the concept of "boundary layer". How is it used in determining a "two-dimensional friction line"? (4 marks)
- b) A towing tank results were recorded for a model having the principal particulars given below as:

L = 2.496 m
 Displacement = 27.41 kg
 Wetted surface area = 0.952 sq.m
 Scale factor = 50

| Model speed (m/s) | Drag (grams) |
|-------------------|--------------|
| 1.39 | 498 |
| 1.52 | 655 |
| 1.66 | 720 |
| 1.81 | 824 |
| 1.96 | 1008 |
| 2.11 | 1217 |
| 2.25 | 1407 |

Determine the full scale total resistance and the effective power at full scale speed of 29 knots. (4 marks)

13.

- a) A propeller of a single screw ship has a diameter of 6.0 m and a radially varying pitch as follows:

| | | | | | | | | | |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| r/R | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
| P/D | 0.872 | 0.902 | 0.928 | 0.950 | 0.968 | 0.982 | 0.992 | 0.998 | 1.0 |

Calculate the mean pitch ratio of the propeller. (5 marks)

- b) A propeller of diameter 3.0 m has a speed of advance of 4.5 m/sec. The velocity of water relative to the propeller in the slip stream far astern is 7.5 m/sec. determine the thrust and the efficiency of the propeller using the axial momentum theory. (3 marks)

14. A ship has a speed of 20 knots when the propeller rpm is 180 and the brake power of the engine is 15000 kW. The effective power of the ship at 20 knots

is 10000 kW and the wake fraction is 0.2, the thrust deduction fraction is 0.120 and the relative rotative efficiency is 1.050 based on thrust identity. The shafting efficiency is 0.97. Calculate the delivered power and thrust power, the hull efficiency, propeller open water efficiency and propulsive efficiency, and the propeller thrust and torque.

15. What is cavitation? What are different types of cavitation observed on ship propellers?
16. Write a short note on dock trials and bollard pull trials.
17. Discuss briefly the main features of controllable pitch propellers and ducted propellers.

Section C:

1 out of 3 Questions of 10 Marks Each = 10 Marks

18. A ship propeller of 5.76 m diameter, 0.8 pitch ratio, 0.55 blade area ratio, 0.05 blade thickness fraction and 0.18 boss diameter ratio produces a thrust of 1200 kN with a delivered power of 15000 kW at 150 rpm and 7.5 m per sec speed of advance in sea water. The depth of immersion of the propeller is 6.0 m. A 0.16 m diameter model of this propeller is to be tested in fresh water. Determine for the model propeller: pitch, blade area, blade thickness at shaft axis, boss diameter, speed of advance, revolution rate, thrust, delivered power, total pressure if the Froude numbers of model and the ship propellers are to be made equal. What is the ratio of Reynolds number of the ship propeller to the Reynolds number of the model propeller?
19.
 - a) A 5 m model of a 180 m long ship is towed in a ship tank at a speed of 1.2 m/sec. The towing pull is 11.77 N. Assuming that 60% of the resistance force is due to skin friction, calculate the corresponding speed for the ship in knots and the effective power at this speed, assuming a wetted surface area of 3600 m² of the ship. (5 marks)
 - b) For $R_n = 10^6$, find the coefficient of skin-friction by the Blasius line, Prandtl line, Hughes formula and ITTC 1957 formula. List them in the ascending order. (5 marks)
20. The wave resistance coefficient based on the (hypothetical) data of a large number of ships is given by the following equation:

$$10^3 C_w = a + b C_b + c \frac{L}{B} + d \frac{B}{T} + e LCB$$

Where LCB is the distance of the longitudinal centre of buoyancy forward of amidships divided by the length of the ship; the other parameters have their standard meanings. The values of a, b, c, d and e are given in the following table as functions of the Froude number:

| Froude no. | a | b | c | d | e |
|------------|-------|-------|--------|-------|-------|
| 0.1 | 0.005 | 0.010 | -0.001 | 0.010 | 0.005 |
| 0.200 | 0.582 | 0.160 | -0.035 | 0.085 | 0.015 |
| 0.250 | 0.930 | 0.240 | -0.065 | 0.150 | 0.025 |

Determine the effective power as a function of speed of a ship of length 100 m, breadth 20 m, draft 8 m, block coefficient 0.675 and LCB 2 per cent of length abaft amidships. The wetted surface is 3100 sq.m. The viscous resistance is given by ITTC line with a roughness allowance of 0.4×10^{-3} . The effect of appendages, aerodynamic resistance and other factors may be taken as 15 percent of the calculated resistance.