Indian Maritime University

(A Central University, Govt of India)

End Semester Examinations – December 2022

Programme Name: M. Tech (NAOE)

Semester: I

Subject Code: PG11E2101

Subject Name: Resistance & Propulsion

Date: 02.01.2023	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 section.

Section-A

Answer all the questions. Each question carries one mark.
Choose the correct answer. *(10 x 1 mark= 10 m)*

1. Identify the component of resistance which is difficult to be determined from ship model experiments
   a. Frictional resistance
   b. Wave resistance
   c. Total bare hull resistance
   d. Appendage resistance
2. What will be the physical correction used in model testing in a towing tank to correct the flow to be identical to the full scale flow?
   a. Using studs as turbulence stimulator
   b. Using sand-strip as turbulence stimulator
   c. Using trip wire as turbulence stimulator
   d. All of the above
3. The relative rotative efficiency is generally assumed to be scale-independent. Is this statement true or false?
   a. True
   b. False
4. The cavitation number is defined as the ratio of the difference between the static pressure in the flow and the vapor pressure, in the numerator and the dynamic pressure, in the denominator. State whether the statement " the larger the cavitation number, the more likely cavitation is" is true or false.
   a. True
   b. False
5. The forces that act on a propeller blade arise from _____
   a. Centrifugal force on each blade
   b. Thrust of the propeller

c. Torque on the propeller
d. All of the above

6. The evaluation of the self-propulsion test requires the resistance characteristics and the open-water characteristics of the stock propeller. The standard used by the 1978 ITTC is the _____
   a. Thrust identity approach
   b. Torque identity approach
   c. Froude's similarity approach
7. If the line generating the helicoidal surface is _____ to the axis about which it rotates when advancing along it, the helicoidal surface and the propeller blade defined by it are said to have no rake.
   a. Parallel
   b. Perpendicular
   c. In line
   d. At an oblique angle
8. Which characteristic will help to determine that the design of propeller is applicable to tugs, tow boats and trawlers
   a. Maximum efficiency when towing at free running speed
   b. Perform more efficiently in more than one operating condition
   c. Low static pull
   d. Low speed when running free
9. State whether the statement "Water jet propulsion systems are always free from cavitation" is true or false.
   a. True
   b. False
10. Find the odd man out with respect to the propeller material:
   a. Easy to cast
   b. High strength and toughness
   c. Low fatigue strength
   d. Low density

Section-B

*Answer any **Five** out of **Seven** questions.*
Each question carries 8 marks. *(5 x 8 marks= 40 m)*

11. A ship of length 100 m and wetted surface of 2700 sq.m has a speed of 15 knots. A 4.0 m long geometrically similar model of the ship has a total resistance of 25.0 N at the corresponding speed. Determine the total resistance of the ship assuming a form factor of 1.05. $v_m = 1.139 \times 10^{-6}$ m^2/s & $v_s = 1.188 \times 10^{-6}$ m^2/s.

12. A propeller of diameter 4.0m has an rpm of 180 when advancing into sea water at a speed of 6.0 m/s. The element of the propeller at 0.7R produces a thrust of 200 kN per m. Determine the torque, the axial and rotational inflow factors, and the efficiency of the element.

13. Describe the phenomenon of propeller cavitation and its harmful effects. Describe the different types of propeller cavitation and the steps that can be taken during propeller design to minimize the risk of cavitation.
14. Explain the wake measurements that are carried out to determine the radial and circumferential distribution of wake velocity.
15. A newly designed bulk carrier 852 ft long displaces 100000 tonnes at design draft. Resistance tests have shown that the effective power, including appendage allowances is 12,860 horsepower at a design speed of 16.5 knots. Propulsion factors measured in self-propelled model tests are given below:

Wake fraction	0.325
Thrust deduction factor	0.178
Relative rotative efficiency	1.025

The propeller test revealed that at its design point the propeller's open water efficiency is 0.685. Shaft transmission efficiency is estimated at 0.990 and a service power allowance of 20 percent has been chosen. From the data given, calculate the ship's propulsive efficiency and service shaft horsepower.

16. Whether the design of towing duty propellers is more complex than that of free running propellers? Please justify your answer.
17. List down the advantages and disadvantages of waterjet propulsion over the conventional screw propellers.

Section-C

*Answer any **One** out of **Three** questions.*
Each question carries 10 marks. *(1 x 10 marks= 10 m)*

18. Consider the propeller and ship described below:

Density of sea water	1025 kg/cu.m
Kinematic viscosity of seawater	1.19x10-6m2/s
Kinematic viscosity of fresh water	1.14x10-6m2/s
Wake fraction	0.135
Propeller diameter	4.5 m
Advance coefficient	0.833
Propeller rps	3
Thrust coefficient	0.1594
Relative rotative efficiency	0.95
Open water efficiency	0.684

Estimate the quasi propulsive coefficient for the vessel.

19. The following data relate to the resistance test on a ship model:
Model length = 4.3 m, Model wetted surface area = 3.75 sq.m and model resistance at 1.5 m/s is 18 N.
The form factor was estimated to be 1.15 and the scale factor is 30.
The viscosity of fluid in fresh water is 1.140×10^{-6} m^2/s and viscosity of fluid in sea water is 1.190×10^{-6} m^2/s.
Determine the effective power of the ship using ITTC correlation line without form factor and effective power using ITTC correlation line with a form factor and compare the results.

20. The following data relate to the self-propulsion test on the model of a single-screw ship.
Model speed is 1.33 m/s,
Propeller diameter is 0.19 m,
Pitch ratios is 0.8
Revolutions at ship self-propulsion point is 10 per sec,
Towed model resistance corresponding to the ship self-propulsion point is 18.5 N,
Thrust at self-propulsion point is 22.42 N
Torque at self-propulsion point is 0.58 Nm

Open water data for the Wageningen propeller B4.40 for P/D =0.80, the following relationships are suitable:

$K_T = 0.320\left[1 - \left(\frac{J}{0.60}\right)^{1.3}\right]$ $\qquad$ $K_Q = 0.0360\left[1 - \left(\frac{J}{0.98}\right)^{1.6}\right]$

By maintaining thrust identity, determine the Quasi-propulsive coefficient.