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UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION
MARCH 2025 SEMESTER SESSION

SUBJECT CODE	:	**LDD31202**
SUBJECT TITLE	:	**SHIP RESISTANCE AND PROPULSION**
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	**DIPLOMA OF ENGINEERING TECHNOLOGY IN SHIP DESIGN**
TIME / DURATION	:	**2.00 PM - 5.00 PM (3 HOURS)**
DATE	:	**23 JUNE 2025**

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of TWO (2) section; Section A and Section B.
4. Answer ALL in Section A and ONLY TWO (2) in section B
5. Answer ALL questions in the answer booklet provided.
6. Answer all questions in English only.

THERE ARE 7 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

(a) It is impossible to model the vessel complying with both Froude numbers and Reynolds number. Therefore, it is not possible to directly convert the total resistance of the model to the total resistance of the ship using directly the scale ratio. It requires some conversion. Explain the extrapolation procedure on how the values of resistance forces in the model scale are converted to full scale?

[8 marks]

(b) The dimensional analysis of the resistance of a ship can be expressed in its final form of three dimensionless number. One of the number is called Euler number. Name the other two non-dimensional numbers.

[4 marks]

(c) Explain the meaning of 'boundary layer' with the aid of a sketch.

[6 marks]

(d) If the body of a ship is rather blunt at the after end the flow may detach at some point, called the separation point. State the effect of this separation point to the resistance of the ship.

[2 marks]

Question 2

(a) Usually, towing tanks incorporate a correction factor, called correlation allowance C_A. Explain why correlation allowance is used in extrapolation of model scale drag to full-scale?

[2 marks]

(b) A product tanker is 140 m long and has a speed of 15 knots with a corresponding model length of 4.9 m. The resistance is measured to be 19 N in the model basin. The wetted surface of the full-scale ship is 3300 m^2. The correlation allowance, C_A = 0.0004, where you can use the following relationship.

$$C_{TS} = C_{FS} + C_R + C_A$$

Following the ITTC 1957 approach, determine the followings:

(i) Model speed

[3 marks]

(ii) Wetted surface area of the model

[2 marks]

(iii) Full-scale resistance

[11 marks]

(iv) Effective power.

[2 marks]

Question 3

(a) With the aid of appropriate sketch, describe the following propeller geometric features and its influence on the overall propulsive performance.

(i) Expanded area ratio

[2 marks]

(ii) Chord

[2 marks]

(iii) Camber

[2 marks]

(iv) Skew

[2 marks]

(v) Rake

[2 marks]

(b) Explain why does the angle of the propeller blade change with increasing distance from the hub even though the pitch is constant throughout the radius of the propeller blade? Show some calculations to proof the above statement. You may choose the radius fraction *r/R* at 0.2R, 0.5R, 0.75R, 0.95R and 1.0R in proofing the above. The following relationship can be used:

$$\tan\theta = \frac{P}{2 * \pi * r}$$

where P is the pitch of the propeller, r is the radius of the propeller and θ is the geometrical pitch angle.

[10 marks]

SECTION B (Total: 40 marks)

INSTRUCTION: Answer only TWO (2) questions.

Question 4

You are a naval architect designing a propeller for a crude oil carrier. For a client Global Jaya Shipping, you have chosen three different propellers, Wageningen B4.40, B4.55 and B.4.70 propeller. The following data are available.

Delivered Power	PD = 5000 kW
Quasi Propulsive Coefficient	η_D = 0.62
Shaft Efficiency	η_S = 0.98
Diameter of propeller	D = 4.5 m
Shaft centerline distance from DWL	h = 4.5 m
Thrust deduction factor	t = 0.155
Wake fraction	w = 0.252
Density of water	ρ =1.025 tonnes/m^3
Service speed of vessel	V = 14.1 knots

Using the Bp-δ chart for B4.40, B4.55 and B.4.70 determine the;

(a) the *Bp* or $K_Q.^{1/4} . J^{-3/4}$

[2 marks]

(b) Open water pitch diameter ratio, *P/D*

[3 marks]

(c) Open water efficiency, η_o

[3 marks]

(d) The advance coefficient, *J*

[6 marks]

(e) The propeller shaft rate of turn in rev/min, *N*

[6 marks]

Question 5

The open water data of a MAU series propeller is tabulated in table 1. The open water diagram is for a 6.15 diameter propeller for a **twin screw** Japan Maritime Self-Defence Force (JMSDF) Landing Helicopter Dock Ship (LHD), *JS Ozumi*. Plot the K_T-$10K_Q$-J chart using a graph paper and from the chart, if the ship is running at 30 knots; with its propeller running at 220 rpm, with its wake fraction at 0.05 and the thrust deduction factor at 0.16, determine the:

a) The maximum efficiency obtainable for this propeller, at the appropriate coefficient of advance

[11 marks]

b) The thrust delivered by a single screw in kN

[3 marks]

c) The torque produced by a single screw in kNm

[4 marks]

d) The total resistance of the ship in kN

[2 marks]

Please indicate the J, K_T and K_Q values in your chart.

Table 1 Open Water Characteristics for MAU series Propeller

J	K_T	$10K_Q$	ηo
0.00	0.40	0.51	0.00
0.09	0.38	0.50	0.11
0.17	0.36	0.47	0.21
0.26	0.33	0.44	0.30
0.34	0.29	0.40	0.40
0.43	0.25	0.36	0.48
0.52	0.22	0.32	0.56
0.60	0.18	0.27	0.62
0.69	0.14	0.22	0.67
0.77	0.09	0.17	0.68
0.82	0.07	0.14	0.66
0.86	0.05	0.11	0.59
0.90	0.02	0.08	0.43
0.94	0.00	0.05	0.00

Question 6

The following particulars of a ship are given for a model length of 6 meters, breadth of 0.86 meters and draft of 0.36 meters. The block coefficient C_B and the wetted surface of the model, S_M are 0.60 and 6.04 m^2 respectively. At the towing speed of 4 knots, the total resistance of the model was at 66.5 N. Therefore, determine the followings for a similar ship which is 96 m long:

(i) corresponding dimensions as listed in Table 1

[8 marks]

(ii) total resistance of the ship using the ITTC1957 extrapolation procedure.

[11 marks]

(iii) effective power of the ship

[1 mark]

Table 1: Particulars of the model and ship for a 96 m long ship.

Particulars	Units	Model	Ship
Length	m	6	96
Breadth	m	0.86	?
Draft	m	0.36	?
Displacement	kg	?	?
Block coefficient	-	0.6	0.6
Wetted surface area	m^2	6.04	?
Speed	knots	4	?

The following relationship can be used:

$$C_B = \frac{\Delta}{L \times B \times T \times \rho}$$

END OF QUESTION