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UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION
OCTOBER 2025 SEMESTER SESSION

SUBJECT CODE	:	**LNB30303** / LNB31604
SUBJECT TITLE	:	**SHIP RESISTANCE AND PROPULSION**
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	**BACHELOR OF ENGINEERING TECHNOLOGY (NAVAL ARCHITECTURE AND SHIPBUILDING) WITH HONOURS**
TIME / DURATION	:	**09.00 AM – 12.00 PM (3 HOURS)**
DATE	:	**28 JANUARY 2026**

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)** sections; Section A and Section B.
4. Answer **ALL** questions in section A. For Section B, answer **THREE (3)** questions **ONLY**.
5. Please write your answers on the OMR answer script and answer booklet provided.
6. Answer all questions in English **ONLY**.
7. Graph paper will be provided.

THERE ARE 15 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

INSTRUCTION: Answer ALL questions.
Please use the objective answer sheet provided.

1. Explain what is meant by the term "corresponding speed"?
   A. "Corresponding speed" is the speed when the speed of the model scale is similar to the speed in full scale
   B. "Corresponding speed" is the speed when the speed-length ratio is constant or the same for model scale and full scale
   C. "Corresponding speed" is the speed when the speed of the full scale is similar to the speed of the model scale multiply by the scale ratio
   D. "Corresponding speed" is the speed when the speed of the towing tank carriage is similar to the calculated model speed

(2 marks)

2. Consider a 5 meter model of a 125 meter ship. If the full scale ship is sailing at 25 knots, calculate how fast does the model have to go in a towing tank using Froude scaling?
   A. 3.02 m/s
   B. 2.57 m/s
   C. 12.86 m/s
   D. 0.514 m/s

(2 marks)

3. Besides the frictional and wave making resistance, name several other resistance components that contribute to the total resistance of a ship.
   A. Viscous pressure resistance and air resistance
   B. Eddy resistance and separation resistance
   C. Wave breaking resistance and appendages resistance
   D. All of the above

(2 marks)

4. Explain briefly what is known as “scale effect” in model resistance tests?
   A. The term ‘scale effect’ in model resistance tests refers to the scaling errors due to the introduction of turbulence stimulator at the bow region of a ship model to induce turbulent flow.
   B. The term ‘scale effect’ in model resistance tests refers to the scaling errors due to the difference in the roughness between the model hull and the full scale hull.
   C. The term ‘scale effect’ in model resistance tests refers to the scaling errors due to the ‘blockage effect’ experienced by the model due to the restriction in depth and width of a smaller tank.
   D. The term ‘scale effect’ in model resistance tests refers to scaling errors due to low Reynolds number imposed to a smaller model testing resulting in scale effect errors in full-scale predictions.

(2 marks)

5. When the water is very deep, the wave pattern of a moving ship at the free water surface consists of the Kelvin transverse and diverging waves. The pattern being contained between the straight lines making an angle α on each side of the line of motion. State the amount of the angle α.
   A. 28 deg 19 min
   B. 19 deg 19 min
   C. 19 deg 28 min
   D. 28 deg 28 min

(2 marks)

6. The resistance of a vessel is greater in shallow water than in deep water conditions. Is this statement correct or incorrect?
   A. Incorrect. The resistance of a vessel is lower in shallow water.
   B. Correct. The resistance of a vessel is greater in shallow water.
   C. Correct. The resistance of a vessel is lower in deep water.
   D. Incorrect. The resistance of a vessel is higher in deep water.

(2 marks)

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

$$\frac{R}{1/2\rho SV^2} = f\left[-,-,\frac{p}{\rho V^2}\right]$$

A. Reynolds and Mach number
B. Cauchy and Mach number
C. Froude and Reynolds number
D. Cavitation and Reynolds number

(2 marks)

8. One of the components of wake is frictional wake when the frictional drag causes retardation of the flow inside the ship's boundary layer. Describe the other two components of wake.

A. Potential wake and wave wake
B. Tangential wake and wave wake
C. Turbulence wake and separation wake
D. Nominal wake and effective wake

(2 marks)

9. Below are blockage correction methods that can be used in correcting the blockage effect in a towing tank. Choose which method IS NOT a blockage effect correction method.

A. Schuster's blockage corrector
B. Tamura's blockage corrector
C. Prohaska's blockage corrector
D. Scott's blockage corrector

(2 marks)

10. Usually, towing tanks incorporate a correction factor, called correlation allowance C_A. Explain why do we need this correlation allowance in the extrapolation to full scale?

A. This correlation allowance is used mainly to correct the scaling effect between the model and full scale.

B. This correlation allowance is used mainly to correct the roughness difference between the model and full scale.

C. This correlation allowance is used mainly to correct the 2D error in the frictional resistance line that was based on plank experiment.

D. This correlation allowance is used mainly to fine–tune model tests with full scale measurements.

(2 marks)

11. 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?

A. The angle change as to maintain a constant inflow angle. The geometric angle has to increase as radius is decreased. Therefore the angle of the propeller blade change with increasing distance from the hub.

B. The pitch at each radius of the propeller blade decrease with increasing distance from the hub. Therefore the angle of the propeller blade change with increasing distance from the hub.

C. The pitch at each radius of the propeller blade increase with increasing distance from the hub. Therefore the angle of the propeller blade changes with increasing distance from the hub.

D. The angle change as to maintain a constant propeller shaft angle. Therefore the angle of the propeller blade change with increasing distance from the hub.

(2 marks)

12. In order to extrapolate the delivered power, P_D, state the three model experiment tests that are required in the ITTC 1978 extrapolation procedure.

A. Open water test, cavitation test and self-propulsion test

B. Open water test, cavitation test and seakeeping test

C. Resistance test, open water test and cavitation test.

D. Resistance test, open water test and self-propulsion test.

(2 marks)

13. A diagram designed to provide guidance in order to avoid excessive cavitation and erosion under average service conditions at sea was given by:

A. Burrill chart

B. Kramer diagram

C. Goldstein chart

D. BP-δ chart

(2 marks)

14. When advance coefficient ratio is maintained model propeller revolutions are smaller than a geometrically similar full scale propeller. Is this statement correct or incorrect?

A. Correct. In maintaining advance coefficient, the propeller revolutions in model scale are smaller than a geometrically similar full scale propeller.

B. Incorrect. In maintaining advance coefficient, the propeller revolutions in model scale are greater than a geometrically similar full scale propeller.

C. Correct. In maintaining advance coefficient, the propeller revolutions in model scale are greater than a geometrically similar full scale propeller.

D. Incorrect. In maintaining advance coefficient, the propeller revolutions in model scale are similar to a geometrically similar full scale propeller.

(2 marks)

15. What are the effects of cavitation to a ship? Name two (2) effects of cavitation.

A. Performance loss and noise
B. Power increase and drag reduction
C. Thrust increase and torque increase
D. Efficiency increase and wave drag increase

(2 marks)

16. If the scaling for the propeller diameter is $\frac{D_S}{D_M} = \lambda$ and for the speed is $\frac{V_S}{V_M} = \lambda^{\frac{1}{2}}$, derive the scaling for propeller shaft revolutions, $\frac{n_S}{n_M}$.

A. λ^2
B. $\sqrt{\lambda}$
C. $\frac{1}{\lambda}$
D. $\frac{1}{\sqrt{\lambda}}$

(2 marks)

(3

17. From a design point of view, what can be done to increase the propeller efficiency? Name two (2) design parameters that do not alter the hull design significantly.

A. Decrease the propeller diameter and increasing propeller turning speed.
B. Decrease the propeller diameter and decreasing propeller turning speed
C. Increase propeller diameter and increasing propeller turning speed
D. Increase propeller diameter and decreasing propeller turning speed.

(2 marks)

18. The propeller lifting line theory is based on:

A. Actuator Disk Theory

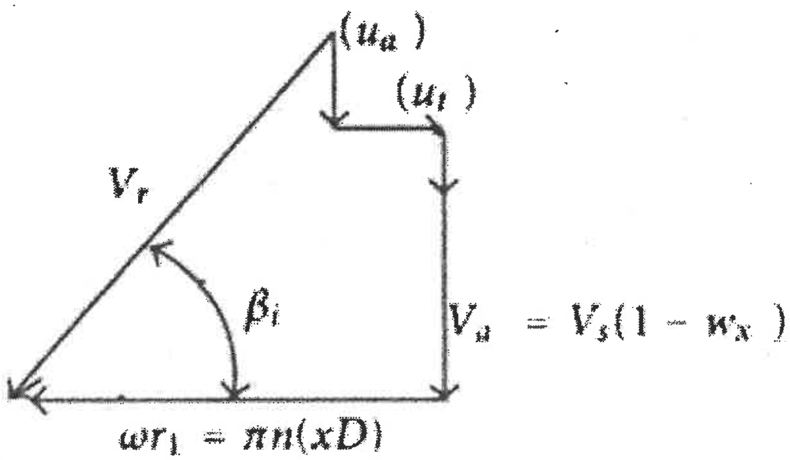
B. Blade Element Theory

C. Blade Element Momentum Theory

D. Circulation Theory

(2 marks)

19. The velocity diagram used in the propeller lifting-line theory is given as in the Figure below. Describe the velocity U_a and U_t.



A. The ship velocity and advance velocity

B. The axial velocity and advance velocity

C. The axial velocity and tangential velocity

D. The axial velocity and resultant velocity

(2 marks)

20. The velocity diagram used in the propeller lifting-line theory is given as in Figure above. The advance angle β_i is defined as:

A. Nose-Tail pitch angle

B. Geometric pitch angle

C. Ideal hydrodynamic pitch angle

D. Zero-lift pitch angle

(2 marks)

SECTION B (Total: 60 marks)

INSTRUCTION: Answer three (3) questions only

Question 1

Figure 1.1 A 25 meter waterjet propelled fast attack gun boat designed for Polis Diraja Malaysia (PDRM) to have a sprint speed of 51.6 knots. This design was based on 17.6m LOMOcean design.

You are a naval architect working with Gading Marine Sdn Bhd, working on a design proposal, proposing a 25m fast attack gun boat (FAG) to the 'Polis Diraja Malaysia' (PDRM). The proposed FAG boat has a volumetric displacement of 90 m^3. The mean chine beam, b is at 7.5 meters, the dead rise angle is at 15 degrees, and the LCG is at 10 meters forward of transom. This craft was designed to have a sprint speed of 51.6 knots (26.545 m/s). Assuming that all the forces on the hull pass through CG, use the Savitsky (1964) procedure to calculate:

(a) the equivalent flat plate lift coefficient, C_{Lb}

(3 marks)

(b) the lift coefficient for a finite deadrise angle, $C_{L\beta}$

(2 marks)

(c) the trim angle, τ

(6 marks)

(d) the mean wetted length, l_M

(3 marks)

(e) the total drag or resistance of this craft, R_T

(6 marks)

Use the Koelbel nomogram (see Annex 37) to estimate the mean wetted length ratio and the equivalent flat plate lift coefficient.

Question 2

You are a propeller designer working in a propeller manufacturing company assigned to design a pair of highly skewed three bladed propeller for a new class corvette using Lifting Line Theory. The thrust required for a single propeller is at 200 kN. The diameter of the screws will be 2.7 m and rotating at 225 rpm. The service speed will be at 16.4 knots and the wake is uniform with the wake fraction at 0.11.

An initial estimate has been found for the ideal efficiency η_i of these propellers as η_i = 0.669. The drag/lift ratios of the skewed blade sections over a range of radius fractions have been estimated to be as in Table 2.1:

Table 2.1 The drag and lift ratios for radius fraction 0.8R, 0.6R, 0.4R and 0.2R.

$\frac{r}{R}$	$\frac{C_D}{C_L}$
0.8	0.055
0.6	0.036
0.4	0.030
0.2	0.047

(a) Calculate the ideal thrust and torque coefficient for radius fraction 1.0R and 0.8R. Fill the blanks in Table 2.2 below. (Please copy down this table to your answer script)

Table 2.2 The calculations of the ideal thrust and torque coefficient for radius fraction 0.6R, 0.4R and 0.2R.

x	*tan β*	*tan βi*	*tan² βi*	λ_i	a`	1-a`	k	$\pi^3 x^3$	k'Ti	k'Qi
1.0										
0.8										
0.6	0.393	0.5866	0.3441	0.352	0.0845	0.9465	0.835	6.699	0.4327	0.0762
0.4	0.5895	0.8799	0.7742	0.352	0.144	0.9155	0.93	1.985	0.2276	0.0401
0.2	1.179	1.7597	3.0965	0.352	0.2494	0.856	1.175	0.248	0.0546	0.0096

(10 marks)

(b) Calculate the overall thrust and torque coefficients and the efficiency of the propellers in viscous flow.

(9 marks)

(c) Calculate the geometric pitch of the propellers assuming that the sections at their ideal angle of incidence and that viscosity effects are negligible.

(1 mark)

(Use the Goldstein Chart for correction as given in Annex 29)

Question 3

You are as a naval architect in a design firm, are required to estimate the delivered power and the shaft speed of a single screw container ship using a model experiment conducted in a towing tank. The ship length is 260 m and has a wetted surface area of 16400 m^2 and a screw propeller of a diameter of 8.2 m. Resistance tests and self-propulsion tests are carried out on a 1/37 scale model of the ship and the results at model speed of 1.69 m/s are as the followings as in Table 3.1 and Table 3.2:

Table 3.1 The resistance test of the 1/37 scale model at model speed of 1.69 m/s with calculated C_{FM}, C_{FS}, ΔC_F and C_{TS}. The resistance test was done in fresh water with its temperature at 15°C.

Speed	R_{TM}	$C_{FM}*10^3$	$C_{FS}*10^3$	ΔC_F*10^3	$C_{TS}*10^3$
(m/sec)	(N)	(-)	(-)	(-)	(-)
1.69	79.1	2.978	1.387	0.156	2.89

Table 3.2 The self-propulsion test of the 1/37 scale model at model speed of 1.69 m/s. The model propeller diameter is at 221.6 mm. The self-propulsion test was done in fresh water with its temperature at 15°C.

Speed	T_M	Q_M	n_M	F_D
(m/sec)	(N)	(Nm)	(rev/sec)	(N)
1.69	76.2	2.149	12.47	20.43

The 1 + k were estimated at 1.25. The open water propeller characteristics chart of the model propeller and the corrected full-scale propeller characteristics is attached in Annex 31 in the booklet. Analyse these data and use the ITTC1978 extrapolation procedure to obtain at corresponding model speed of 1.69 m/s:

(a) the model wake fraction, w_{TM} (5 marks)

(b) the relative-rotative efficiency, η_R (1 mark)

(c) the thrust deduction fraction, t (1 mark)

(d) the ship wake fraction, w_{TS} (1 mark)

(e) the full-scale propeller shaft speed, n_S (9 marks)

(f) the full-scale delivered power of the ship, P_{DS} (1 mark)

(g) the effective power of the ship, P_E (1 mark)

(h) the overall propulsive efficiency, η_D (1 mark)

Plot the $K_T - J^2$ curve required in the open water chart and attached it to your answer script.

Question 4

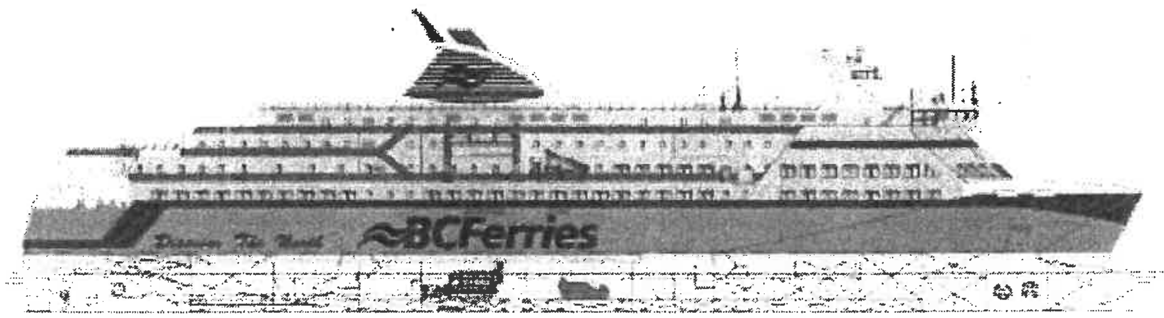


Figure 4.1 'MV Northern Expedition' a RORO ferry designed to be a twin screw ferry

You are a naval architect designing propellers for a twin screw RORO ferry 'MV Northern Expedition' as shown in Figure 4.1 above. For a client British Columbia Ferries (BC Ferries), you have chosen two different designs, Wageningen B4.40 and B4.100 propeller. The B_P-δ chart for B4.40 and B4.100 are given in the booklet. The following data are available as tabulated in Table 4.1 below.

Table 4.1 The data for the RORO ferry 'MV Northern Expedition'

Delivered Power per shaft	P_D = 4550 kW
Quasi Propulsive Coefficient	η_D = 0.62
Shaft Efficiency	η_S = 0.97
Diameter of propeller	D_S = 3.4 m
Shaft centerline distance from DWL	h = 4.5 m
Thrust deduction factor	t = 0.15
Wake fraction	w = 0.25
Density of sea water	ρ_{SW} = 1.025 tonnes/m^3
Service speed of vessel	V_S = 21 knots

(a) Evaluate both propellers in terms of optimum revolution, the open water efficiency and pitch to diameter ratio. Which propeller you will choose based on efficiency alone?

(15 marks)

(b) Determine the minimum blade area ratio required for the propeller in minimizing cavitation risk using Keller's equation. Which propeller you will choose based on the cavitation consideration using Keller's equation?

(5 marks)

Question 5

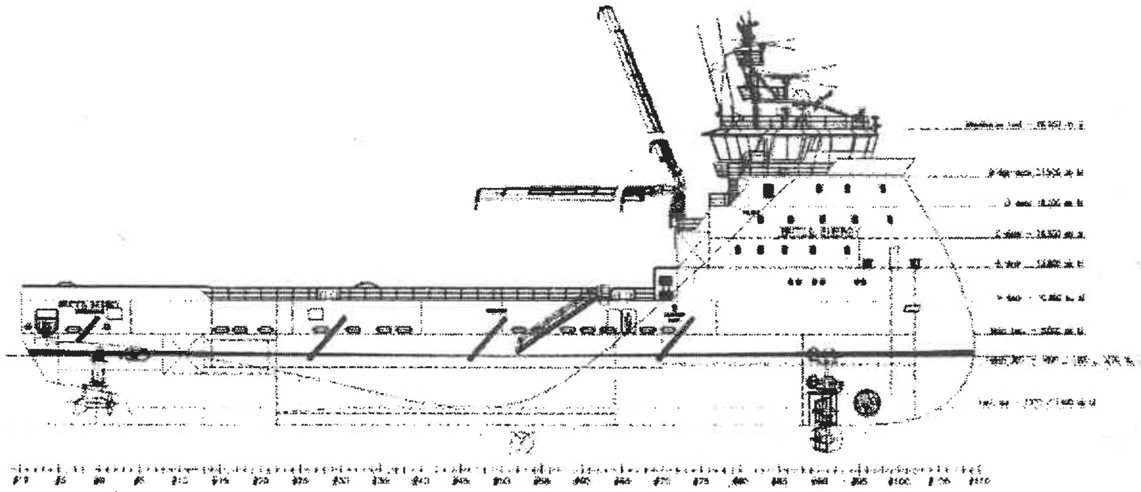


Figure 5.1 'Bourbon Orca' a 83.4 m Platform Supply Vessel with Ulstein X-Bow design owned by Bourbon Offshore Norway AB.

It is required to determine the optimum rotational speed of each propeller fitted to a twin screw platform supply vessel (PSV) 'Bourbon Orca' as shown in Figure 5.1. The PSV has the following parameters for one azimuthing unit as tabulated in Table 5.1. [The K_T-K_Q-J chart for 4 bladed Kort Nozzled Propeller is given in Annex 24 in the booklet]:

Table 5.1 The data for the 83.4m 'Bourbon Orca'

Thrust deduction fraction	$t = 0.19$
Total Resistance of vessel + tug force, for one propeller unit	$R_T = 13.414\ kN$
Propeller diameter	$D = 1.5\ m$
Vessel speed	$V = 1.3\ m/s$
Wake fraction	$w = 0.25$
No of blades	$Z = 4$

(a) Determine the rotational speed of the propeller in RPM for an optimum P/D ratio. To calculate this you must tabulate J and K_T values using the K_T-J^2 relationship.

(15 marks)

(b) Calculate the torque produced and the open water efficiency.

(3 marks)

(c) Calculate the power delivered by the propeller to the water.

(2 marks)

Question 6

A wake analysis was done using CFD RANS in full-scale for a twin screw ship. The local wake measurement was taken at the propeller plane. The results are presented in a contour plot as shown in Figure 7.1. The measurement were taken at radius 1.0R, 0.75R, and 0.5R. The propeller diameter is at 7 m with the hub diameter at 1 m. Integrate the radial wake fraction to obtain the nominal mean wake fraction for this twin screw ship.

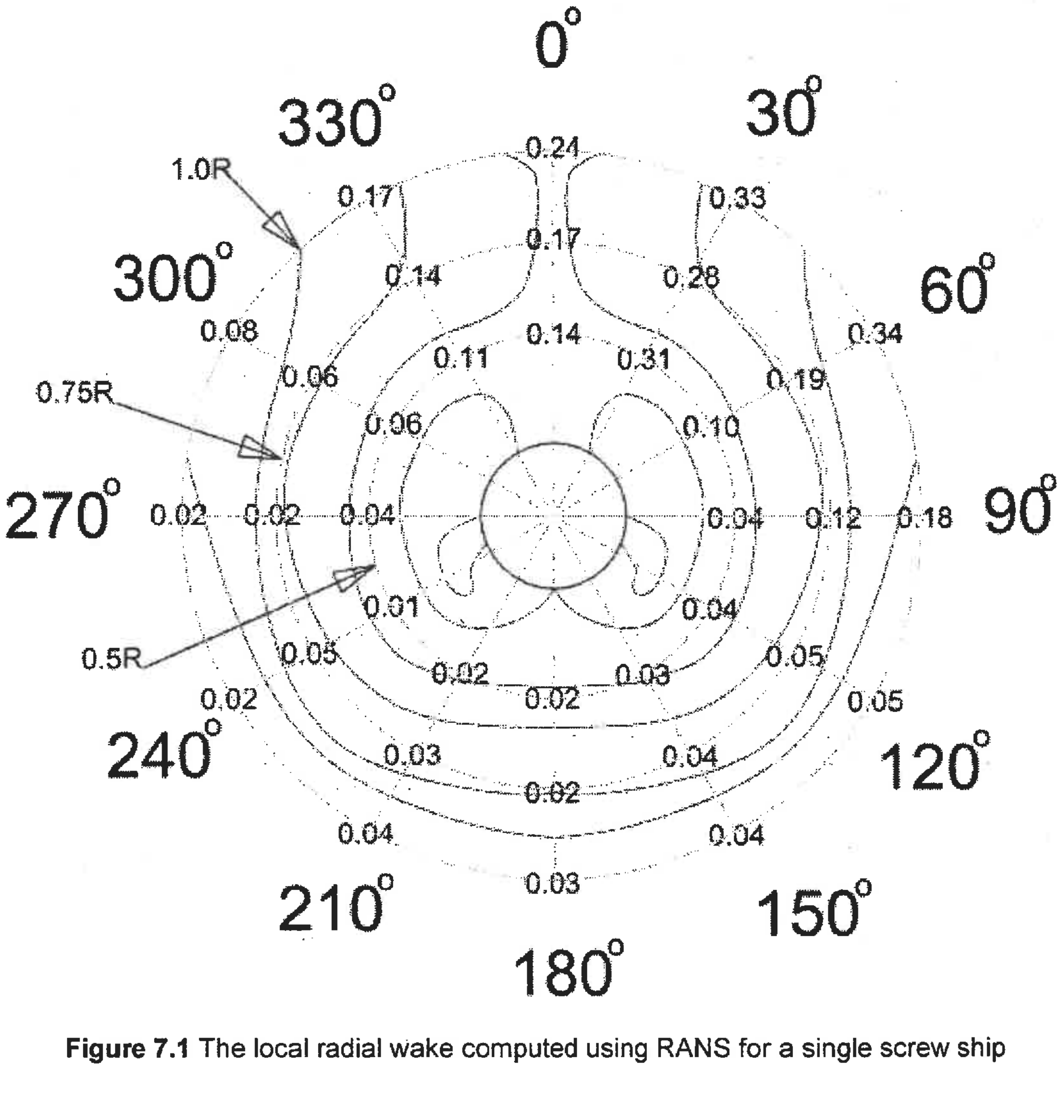


Figure 7.1 The local radial wake computed using RANS for a single screw ship

(20 marks)

END OF EXAMINATION PAPER