Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	FLUID MECHANICS II
COURSE CODE	:	BDA 30203
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. PART A : ANSWER **THREE (3)** FROM **FOUR (4)** QUESTIONS. 2. PART B : ANSWERS **ALL** QUESTIONS. 3. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**. 4. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **SEVEN** (7) PAGES

PART A : ANSWER **THREE** (3) FROM **FOUR** (4) QUESTIONS

Q1 (a) Draw a sketch of the Reynolds apparatus, and explain how the laminar flow can be demonstrated with the help of the apparatus.

(5 marks)

(b) For a steady laminar flow through a circular pipe, prove that the velocity distribution across the section is parabolic and the average velocity is half of the maximum local velocity.

(15 marks)

Q2 (a) Water is pumped from a large lower reservoir to a large higher reservoir. Someone claims that if the head loss is negligible, the required pump head is equal to the elevation difference between two reservoirs. Do you agree? Justify your answer.

(5 marks)

(b) Consider laminar flow of a fluid through a horizontal, square channel with smooth surfaces. If the average velocity of the fluid is doubled, determine the change in the head loss of the fluid.

(5 marks)

(c) Water with a density of 997.05 kg/m^3 flows through a horizontal pipe at a flowrate of 0.25 m^3/s. The pipe diameter which is 200 mm, suddenly enlarges to 400 mm. If the pressure of water in the smaller pipe is 120 kN/m^2, determine :

(i) Loss of head due to sudden enlargement,

(ii) Pressure in the large pipe, and

(iii) Power lost due to enlargement.

(10 marks)

Q3 (a) Briefly explain the following terms;

(i) Substantial derivative.

(ii) Local derivative.

(iii) Convective derivative.

(5 Marks)

(b) One form of fluid movement is rotation and deform angularly. **Figure Q3(b)** shows the rotation and angular deformation caused by velocity variation about z-axis. Derive an equation of rotation about y-axis.

(15 marks)

Q4 (a) Briefly describe the different between friction drag and pressure drag.

(5 marks)

(b) In a wind tunnel, experiments were conducted with a wind speed of 50 km/h on a flat plate of size 2 m long and 1 m wide. The density of air is 1.15 kg/m^3. The plate is kept at such an angle that the lift and drag coefficients are 0.75 and 0.15 respectively. Determine:

(i) the resultant force acting on the flat plat; and

(ii) power exerted by the airstream on the plate.

(8 marks)

(c) A jet plane weighing 29.4 kN and having a wing area of 20 m^2 flies at a velocity of 950 km/h. When the engine delivers 7350 kW, 65 percent of the power is used to overcome the drag resistance of the wing. If the density of atmospheric air is 1.208 kg/m^3, determine the drag and lift coefficients for the wing.

(7 marks)

PART B : ANSWER **ALL** QUESTIONS.

Q5 (a) State the methods that can be used to determine the performance of the centrifugal pumps and state the limitations for each method.

(6 marks)

(b) Discuss the influence of exit blade angle on the centrifugal pump performance.

(4 marks)

(c) A centrifugal pump is discharging 0.03 m^3/s of water against a total head of 20 m. The diameter of the impeller is 400 mm and it is rotating at 1500 rpm. Determine the head and discharge coefficient of the centrifugal pump.

(4 marks)

(d) Determine the head, discharge and ratio of powers of the centrifugal pump if the diameter of the centrifugal pump is 250 mm, running at 3000 rpm and this centrifugal pump is geometrically similar with the centrifugal pump in **Question Q5(c).**

(6 marks)

Q6 (a) Briefly explain the definition of Mach number and why this parameter is so important for the study of compressible fluids flow.

(5 marks)

(b) Determine the velocity of the bullet fired at 20^0C with Mach angle of 30^0 if the specific heat ratio and gas constant for the air are 1.4, 287 J/kg.K respectively,

(6 marks)

(c) A gas with a velocity of 300 m/s is flowing through a horizontal pipe at a section where pressure and temperature are 60 kN/m^2, 40°C respectively. The pipe changes in diameter and at this section the pressure is 90 kN/m^2. If the specific heat ratio and gas constant for the gas are 1.4, 287 J/kg.K, determine the velocity of gas at this section.

(9 marks)

- END OF QUESTION –

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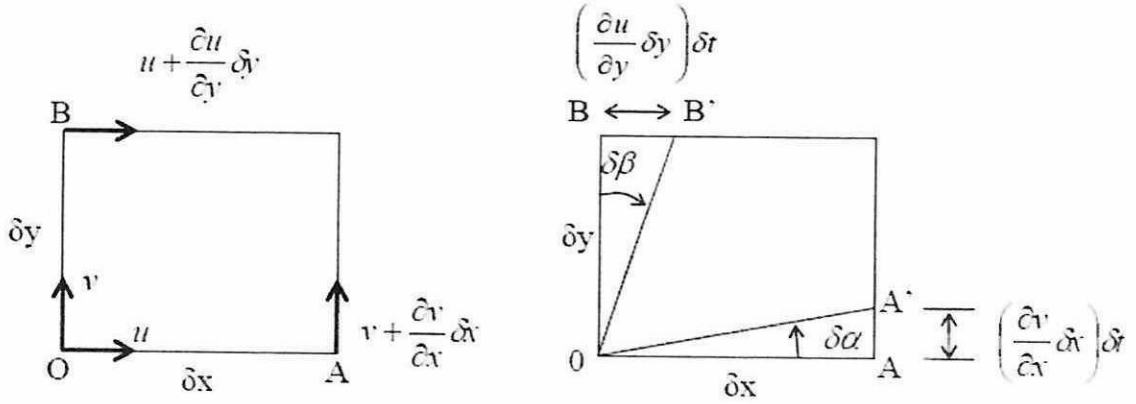

Figure Q3(b) : Rotation and Angular Deformation about z-axis

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List of Formula

1. $\Delta p/l = 2\tau/r$
2. $\tau = -\mu du/dr$
3. $Re = \rho vD/\mu$
4. $p_1/\rho g + v_1^2/2g + z_1 + h_p = p_2/\rho g + v_2^2/2g + z_2 + h_L + h_T$
5. $h_L = K_L v^2/2g$
6. $K_L = [1 - (D_1/D_2)^2]^2$
7. $h_L = flv^2/2gD$
8. $f = 64/Re$
9. $1/f^{0.5} = -1.8 \log [(6.9/Re) + (\varepsilon/3.7D)^{1.1}]$
10. $W = \rho g Q h_L$
11. $F_D = C_D \frac{1}{2} \rho U^2 A$
12. $F_D = C_L \frac{1}{2} \rho U^2 A$
13. $C_H = gH/w^2D^2$
14. $C_Q = Q/wD^3$
15. $C_P = P/\rho w^3 D^5$
16. $Ma = V/c$
17. $\sin \alpha = c/V$
18. $c = (kRT)^{1/2}$
19. $T_0 = T + (V^2/2\, c_p)$
20. $P_1/P_2 = (T_1/T_2)^{k/(k-1)}$
21. $(\rho_1/\rho_2) = (T_1/T_2)^{1/(k-1)}$
22. $c_p = Rk/(k - 1)$

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