Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	FLUID MECHANICS II
COURSE CODE	:	BDA 30203
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	JULY/AUGUST 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

CONFIDENTIAL

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

Q1 (a) Briefly explain the characteristics of laminar flow

(5 marks)

(b) An oil flow through a horizontal circular pipe of diameter 50 mm, 500 m long at the rate of 0.19 l/s. The kinematic viscosity and relative density of the oil are 2.5×10^{-6} m^2/s and 0.8 respectively.

(i) Prove that the flow is laminar flow.

(ii) Determine the pressure gradient and wall shear stress.

(7 marks)

(c) In a pipe of 200 mm diameter, the average velocity of air is found to be 0.15 m/s. If the kinematic viscosity of the air is 1.51×10^{-5} m^2/s.

(i) Determine the maximum velocity of the air and the velocity of the air at 40 mm from the pipe wall.

(ii) Prove that the maximum velocity occurs at the centreline of the pipe.

(8 marks)

Q2 (a) Briefly explain the different between major and minor losses.

(5 marks)

(b) A centrifugal pump is used to deliver 0.04 m^3/s of water from a reservoir to a large tank at a height of 20 m through a 150 mm diameter 100 m long plastic pipe. Based on **Figure Q2(b)**, determine the major loss occur in the piping system. The density and kinematic viscosity of the water are 998.2 kg/m^3 and 1.007×10^{-6} m^2/s respectively.

(6 marks)

(c) Based on **Question 2(b)**, determine the power required to drive the pump if the entrance loss coefficient and efficiency of the pump are 0.8 and 70 % respectively.

(9 marks)

Q3 (a) Briefly explain the definition of potential flow.

(5 marks)

(b) The mass balance for a control volume can be defined as any change of mass within the control volume is equal to the net gain of mass flowing into the volume through the control surface. Based on this definition, derive the equation of mass balance for 3 dimensional, unsteady and compressible fluid flow.

(15 marks)

Q4 (a) Briefly explain the different between streamlined body and blunt body.

(5 marks)

(b) A plastic ball with outside diameter of 80 mm is supported in vertical air stream which is flowing at a velocity of 13 m/s. The density and kinematic viscosity of air are 1.25 kg/m^3 and 0.00015 m^2/s respectively. Based on **Figure Q4(b)**, determine the drag coefficient of the plastic ball.

(7 marks)

(c) Based on **Question Q4(b)**, if the thickness of the plastic ball is 1 mm, determine the density of the plastic. [Volume of sphere = $(4/3)\pi r^3$]

(8 marks)

PART B : ANSWER **ALL** QUESTIONS.

Q5 (a) What is cavitation and how to avoid cavitation from occur.

(5 marks)

(b) A laboratory tests were conducted on a centrifugal pump with 400 mm diameter impeller and rotating at 1500 rpm. The results shows that the pump discharge 0.03 m^3/s of water against a total head of 20 m. If the pump efficiency and the density of the water are 85%, 998.2 kg/m^3 respectively, determine power required by the pump.

(5 marks)

(c) Based on **Question Q5(b)**, determine head, discharge and the ratio of head, discharge, power of the geometrically similar pump with 250 mm diameter impeller and running at 3000 rpm.

(10 marks)

Q6 (a) Differentiate between compressible and incompressible fluid flows.

(5 marks)

(b) A jet-propelled aircraft is flying at 1100 km/h at sea level. Determine the aircraft Mach number. The temperature, gas constant and specific heat ratio of air are 20°C, 0.287 kJ/kg.k and 1.4 respectively.

(5 marks)

(c) A large pressure vessel, fitted with a nozzle, contains air at a pressure of 2943 kN/m^2 (abs.) and at a temperature of 20°C. The pressure at the outlet of the nozzle is 2060 kN/m^2 (abs.). The gas constant and specific heat ratio of air are 0.287 kJ/kg.k and 1.4 respectively. If the diameter of the nozzle is 10 mm, determine the mass flowrate of air flowing at the outlet of the nozzle.

(10 marks)

- END OF QUESTION –

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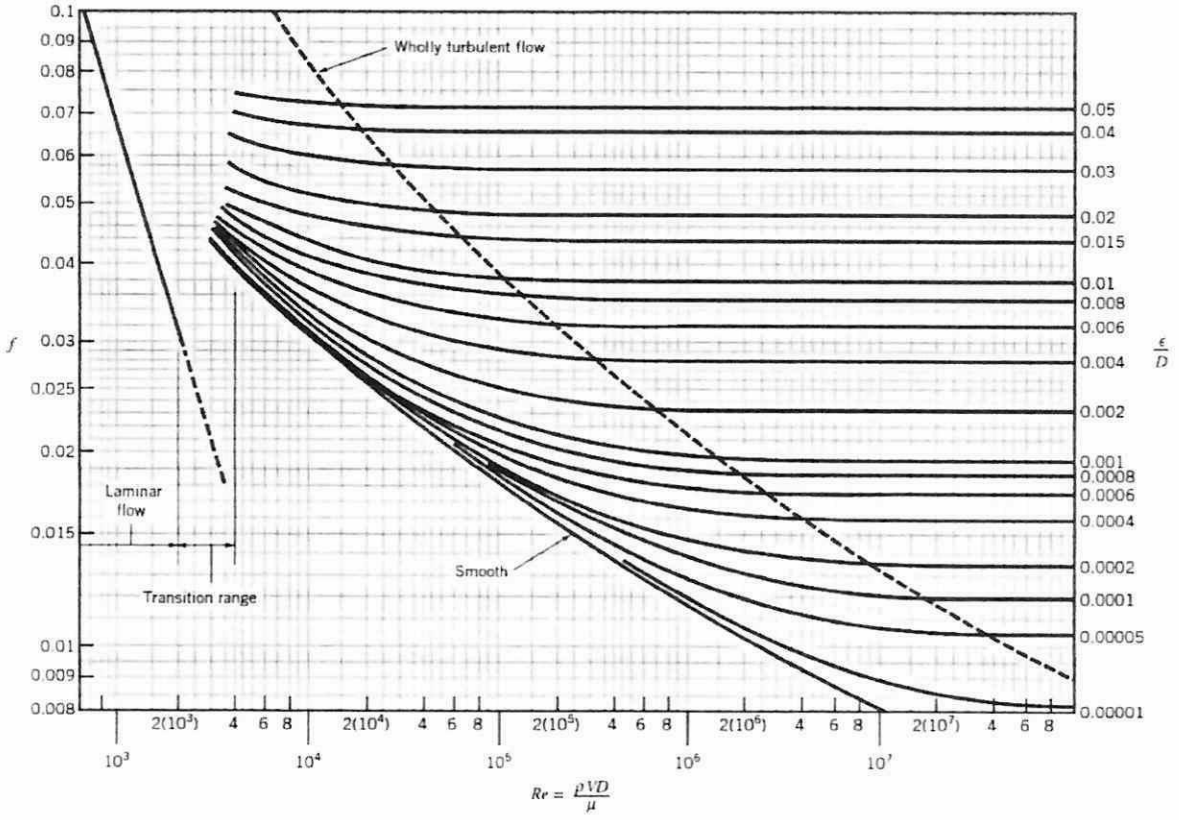

Figure Q2(b) : Moody Chart

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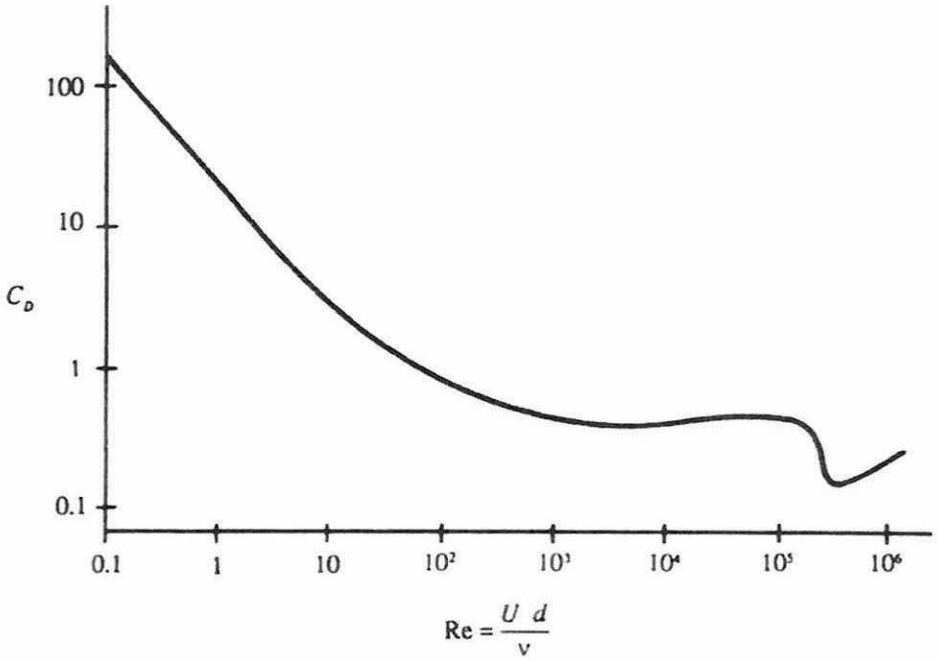

Figure Q4(b) : Drag Coefficient of a Smooth Sphere

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List of Formula

1. $Re = \rho vD/\mu$
2. $Q = \pi D^4 \Delta p/128\mu l$
3. $\Delta p/l = 4\tau_w/D$
4. $V = V_c/2$
5. $u_r = V_c\,[1 - (2r/D)^2]$
6. $p_1/\rho g + v_1^2/2g + z_1 + h_p = p_2/\rho g + v_2^2/2g + z_2 + h_L + h_T$
7. $h_L = K_L v^2/2g$
8. $h_L = flv^2/2gD$
9. $f = 64/Re$
10. $W = \rho g Q h_L$
11. $F_D = C_D \tfrac{1}{2} \rho U^2 A$
12. $W = \rho g Q h_p$
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. $c = (kRT)^{1/2}$
18. $T_0 = T + (V^2/2\,c_p)$
19. $P_1/P_2 = (T_1/T_2)^{k/(k-1)}$
20. $(\rho_1/\rho_2) = (T_1/T_2)^{1/(k-1)}$
21. $c_p = Rk/(k-1)$
22. $\rho = P/RT$