Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	FLUID MECHANICS II
COURSE CODE	:	BDA 30203
PROGRAMME	:	BDD
EXAMINATION DATE	:	JUNE/JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	1. PART A : ANSWER **THREE** (3) FROM **FOUR** (4) QUESTIONS. 2. PART B : ANSWER **ALL** QUESTIONS.

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

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

Q1 (a) Discuss briefly the following terms;

(i) Laminar flow;

(ii) Transition flow; and

(iii) Turbulent flow.

(5 marks)

(b) Show that the equation to determine the velocity profile for fully developed laminar flow is

$$u_r = (\Delta p D^2/16\mu l)[1 - (2r/D)^2]$$

(8 marks)

(c) Based on equation in question Q1(b), plot the velocity profile for fully developed laminar flow if pressure drop, dynamic viscosity of the fluid, pipe diameter and length of the pipe are 7702 Pa, 0.41 N.s/m^2, 0.025 m and 9 m respectively.

(7 marks)

Q2 (a) Not all conduits used to transport fluids are round in cross section. Explain briefly why heating and air conditioning ducts are often rectangular in cross-section.

(5 marks)

(b) Water with density and kinematic viscosity of 1000 kg/m^3. 1.02 × 10^{-6} m^2/s is pumped between two reservoirs at 0.0057 m^3/s through 122 m long, 5.08 cm diameter pipe as shown in **Figure Q2(b)**. The roughness ratio (ε/d) of the pipe is 0.001 and the value of minor losses coefficient are shown in **Table 1**. If the efficiency of the pump is 80 %, determine the required pump power.

Table 1 : Minor Losses Coefficient

Minor Losses Element	Coefficient
Sharp entrance	0.5
Open globe valve	6.9
Bend radius	0.15
Screwed regular 90^0 elbow	0.95
Half-open gate valve	2.7
Sharp exit	1

Q3 (a) Describe briefly the different between Momentum equation, Euler equation and Navier Stokes equation.

(5 marks)

(b) Momentum equation for a control volume can be defined as the net force acting on the fluid element is equals to mass times the acceleration of the element. Based on this definition, show that the Momentum equation in non-conservation form in y-direction is

$$\rho(Dv/Dt) = -(\delta p/\delta y) + (\delta \tau_{xy}/\delta x) + (\delta \tau_{yy}/\delta y) + (\delta \tau_{zy}/\delta z) - \rho g_y$$

(10 marks)

(c) Based on equation in question Q3(b), derive the momentum equation in y-axis for ideal fluid.

(5 marks)

Q4 (a) Explain briefly the concept of Magnus effect.

(5 marks)

(b) The effect of spin on tennis ball lift force can be determined using **Figure Q4(b)**. If the tennis ball with a mass of 0.06 kg and a diameter of 65 mm is hit at 72 km/h with a backspin (slice) of 4800 rpm, determine if the ball will fall or rise under the combined effect of gravity and lift force due to spinning shortly after being hit. Assumed the density of the air is 1.184 kg/m^3.

(15 marks)

PART B : ANSWER **ALL** QUESTIONS.

Q5 (a) **Figure Q5(a)** shows a pump performance curves. Draw this performance curves in your answer script and label the pump head curve, the pump efficiency curve, the shut-off head, the free delivery and the best efficiency point.

(5 marks)

(b) A centrifugal pump produces a flowrate of 0.03 m^3/s when operating at 1750 rpm against a 61 m head. Determine the pump's flowrate and head if the pump speed is increased to 3500 rpm.

(8 marks)

(c) To study the pump characteristic as shown in Question 5(b), a 1/5 scale, geometrically similar model operated at the same speed is to be tested in the laboratory. Determine the required model discharge and head. Assume both model and prototype operates with the same efficiency.

(7 marks)

Q6 (a) Explain briefly the definition of compressible fluid flow.

(5 marks)

(b) Based on an equation below, compare the effect of variations in flow cross sectional area on fluid velocity for different Mach Number (Ma) on isentropic flow.

$$dV/V = -(dA/A)[1/(1 - Ma^2)]$$

(9 marks)

(c) The properties of fluid at a location where the Mach number is unity ($Ma = 1$) are called critical properties. The gas constant (R), specific heat at constant pressure (c_p) and specific heat ratio (k) of air are 0.287 kJ/kg.K, 1.005 kJ/kg.K, 1.4 respectively. Determine the critical temperature, pressure and density of air at 200 kPa, 100^0C and 250 m/s.

(6 marks)

- END OF QUESTION –

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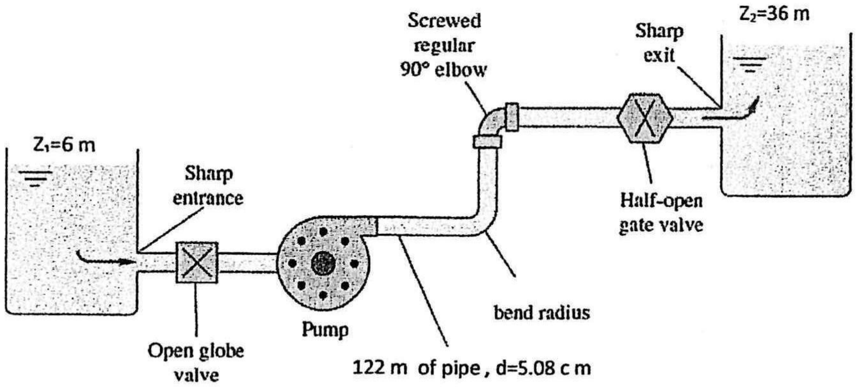

Figure Q2(b)

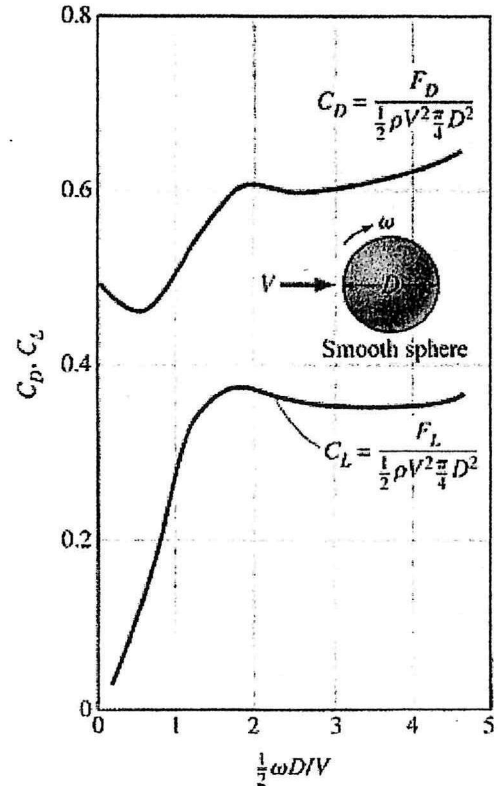

Figure Q4(b)

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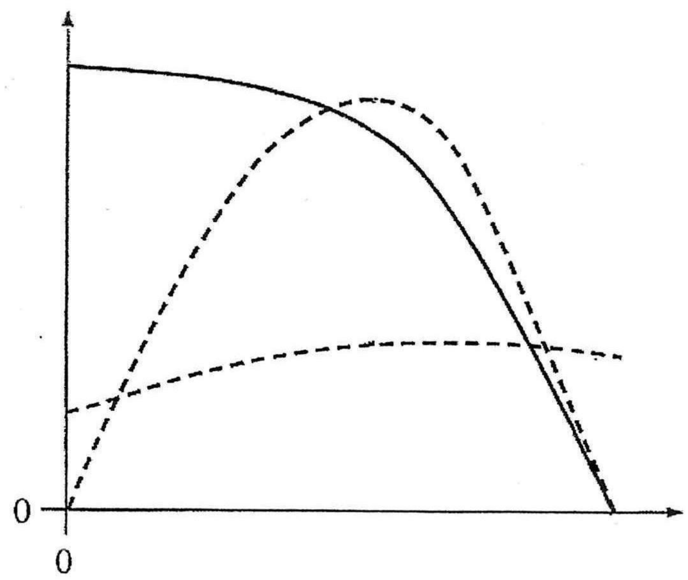

Figure Q5(a)

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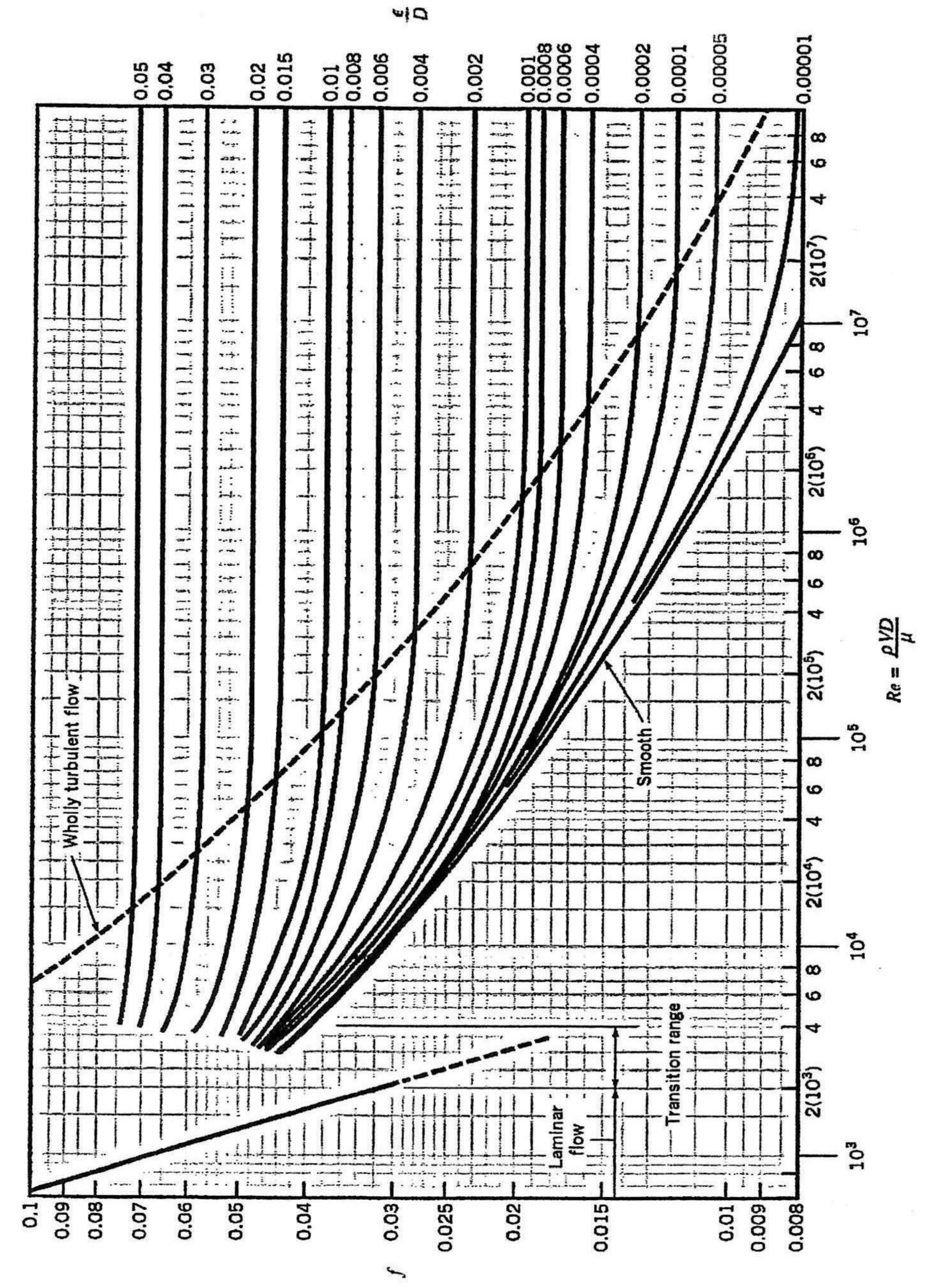
Moody Chart



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List of Formula

1. $\Delta p/l = 2\tau/r$
2. $\tau = -\mu\,\delta u/\delta r$
3. $u_r = (\Delta p D^2/16\mu l)[1 - (2r/D)^2]$
4. $Re = \rho v D/\mu$
5. $P_1/\rho g + V_1^2/2g + z_1 = P_2/\rho g + V_2^2/2g + z_2 + h_L + w - q$
6. $W = \rho g Q h_p$
7. $h_L = f l V^2/2gD\backslash$
8. $h_L = K_L V^2/2g$
9. $f = 64/Re$
10. $1/f^{0.5} = -1.8 \log[(6.9/Re) + (\varepsilon/3.7D)^{1.1}]$
11. $\eta = (W_{out}/W_{in})100\%$
12. $F_L = C_L \frac{1}{2}\rho U^2 A$
13. $C_H = gH/N^2D^2$
14. $C_Q = Q/ND^3$
15. $C_P = P/\rho N^3 D^5$
16. $T_0 = T + (V^2/2c_p)$
17. $P_0/P = (T_0/T)^{k/(k-1)}$
18. $P_0 = \rho_0 R T_0$
19. $T^*/T_0 = [2/(k+1)]$
20. $P^*/P_0 = [2/(k+1)]^{k/(k-1)}$
21. $\rho^*/\rho_0 = [2/(k+1)]^{1/(k-1)}$

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