Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	FLUID MECHANICS II
COURSE CODE	:	BDA 30203
PROGRAMME	:	BDD
EXAMINATION DATE	:	DECEMBER 2019/JANUARY 2020
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 **EIGHT (8)** PAGES

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

Q1 (a) Describe briefly the difference between pipe flow and open channel flow.

(5 marks)

(b) From Newton Second Law of motion, derive an equation for fully developed laminar flow that shows the relation between velocity profile and centerline velocity as shown below.

$$u_r = V_C\,[1 - (2r/D)^2]$$

(15 marks)

Q2 (a) Describe briefly the definition and the use of hydraulic radius.

(5 marks)

(b) Water with density and dynamic viscosity of 998 kg/m^3, 1.4 x 10^{-3} Ns/m^2 respectively flows through a 50 mm diameter, 15 m long pipe. If the pipe has an absolute roughness of 0.00007 m, determine the head loss and power required to overcome friction for a flowrate of 3 liters/min and 60 liters/min.

(15 marks)

Q3 (a) Describe briefly the following terms;

(i) Steady flow;

(ii) Incompressible flow; and

(iii) Inviscid flow.

(5 marks)

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(b) Continuity equation 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, show that the continuity equation for compressible flow is

$$\delta\rho/\delta t + \delta\rho u/\delta x + \delta\rho v/\delta y + \delta\rho w/\delta z = 0$$

(10 marks)

(c) Based on the equation in question Q3(b), derive the continuity equation for incompressible and steady flow.

(5 marks)

Q4 (a) Describe briefly the definition and the importance of drag and lift force.

(5 marks)

(b) A 50 cm x 50 cm x 1 m empty rectangular cross section garbage bin with a thickness of 5 cm is found in the morning tipped over due to high wind speed the night before. If the density of the air, the wind speed and the drag coefficient of the garbage bin are 1.25 kg/m^3, 11.5 m/s, 2.2 respectively, determine the density of the garbage bin.

(10 marks)

(c) Based on question Q4(b), determine whether the garbage bin will tipped over or not if the wind speed is 10 m/s and the density of the garbage is 130 kg/m^3.

(5 marks)

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PART B : ANSWER **ALL** QUESTIONS.

Q5 (a) Describe briefly the following terms;

(i) Shut off head;

(ii) Free delivery; and

(iii) Best efficiency point.

(5 marks)

(b) **Figure Q5(b)** shows the performance curves for a centrifugal pump used to pump water when it operates at 1745 rpm. The impeller diameter is 6 cm and the density of the water is 998 kg/m^3. Determine;

(i) the pump performance at its best efficiency point; and

(ii) head, capacity and power coefficient.

(9 marks)

(c) A new pump is used to pump a liquid with a density of 1226 kg/m^3 at head and flowrate of 450 cm, 2400 cm^3/s respectively. Based on question Q5(b) and by using pump scaling laws, determine;

(i) impeller diameter;

(ii) impeller speed; and

(i) pump brake horsepower.

(6 marks)

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Q6 (a) Explain briefly the defination of shock wave.

(5 marks)

(b) Air at pressure and temperature of 200 kPa, 373.2 K flows through a duct at Mach Number of 0.8. The gas constant and specific heat ratio of air are 0.287 kJ/kg.k, 1.4 respectively. Determine;

(i) air velocity;

(ii) stagnation pressure;

(iii) stagnation temperature; and

(iv) stagnation density.

(8 marks)

(c) Nitrogen enters a converging diverging nozzle from a reservoir at a pressure of 700 kPa and temperature of 400 K. The gas constant and specific heat ratio of nitrogen are 0.2968 kJ/kg.k, 1.4 respectively. Determine;

(i) critical pressure

(ii) critical temperature;

(iii) critical density; and

(iv) critical velocity,

(7 marks)

- END OF QUESTION –

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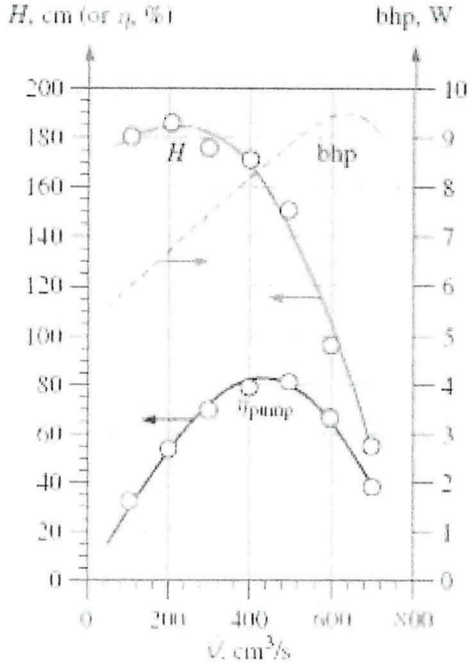

Figure Q5 (b)

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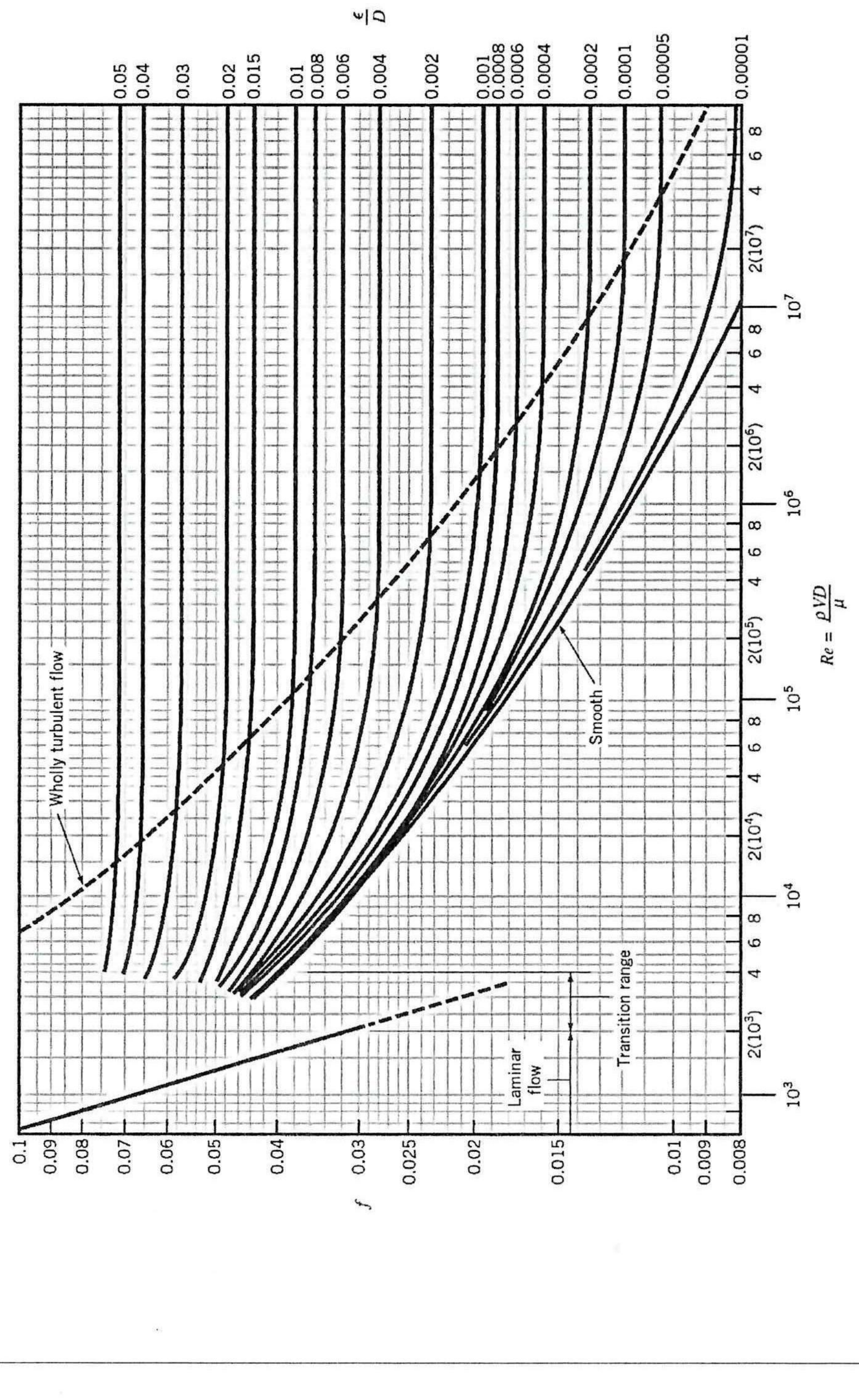
Moody Chart



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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. $h_L = flv^2/2gD$
5. $f = 64/Re$
6. $1/f^{0.5} = -1.8 \log[(6.9/Re) + (\varepsilon/3.7D)^{1.1}]$
7. $W = \rho g Q h_L$
8. $F_D = C_D \, \tfrac{1}{2} \rho U^2 A$
9. $C_H = gH/w^2D^2$
10. $C_Q = Q/wD^3$
11. $C_P = P/\rho w^3 D^5$
12. $Ma = V/c$
13. $c = (kRT)^{1/2}$
14. $T_0 = T + (V^2/2c_p)$
15. $P_0/P = (T_0/T)^{k/(k-1)}$
16. $(\rho_0/\rho) = (T_0/T)^{1/(k-1)}$
17. $T^*/T_0 = [2/(k+1)]$
18. $P^*/P_0 = [2/(k+1)]^{k/(k-1)}$
19. $\rho^*/\rho_0 = [2/(k+1)]^{1/(k-1)}$

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