Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017

COURSE NAME	:	FLUID MECHANICS II
COURSE CODE	:	BDA 30203
PROGRAMME	:	BDD
EXAMINATION DATE	:	DECEMBER 2016 / JANUARY 2017
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 **NINE (9)** PAGES

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

Q1 (a) Explain why heating and air conditioning ducts are often rectangular in cross section.

(5 marks)

(b) Fluid with density and kinematic viscosity of 900 kg/m^3, 0.0002 m^2/s respectively flows upward through an inclines pipe. The diameter of the pipe is 6 cm and the pipe inclination is 40°. The pressure at point 1 is 350 kPa and pressure at point 2 is 250 kPa. If the flow is to remain laminar, determine;

(i) average velocity;

(ii) flowrate;

(iii) distance between point 1 and point 2;

(iv) wall shear stress;

(v) centerline velocity; and

(iv) length of the entrance region.

(15 marks)

Q2 (a) Describe the definition of major and minor losses that occur when fluid flows in pipe.

(5 marks)

(b) A 18 m^3 vented tanker is to be filled with fuel oil from an underground reservoir using a 20 m long, 5 cm diameter plastic hose with a slightly rounded entrance ($K_L = 0.12$) and two 90° smooth bends ($K_L = 0.3$) as shown in **Figure Q2(b)**. The density and dynamic viscousity of the fuel oil are 900 kg/m^3, 0.045 kg/m.s respectively. The elevation difference between the oil level in the underground reservoir and the location where the hose is discharged is 5 m. If the flow is to be laminar, determine;

(i) maximum flowrate;

(ii) time required to fill the tank;

(iii) head loss;

(iv) power required to push the fluid to flow at maximum flowrate; and

(v) power required by the pump if the efficiency of the pump is 85%.

(15 marks)

Q3 (a) Describe briefly the definition of streamline and discuss what streamline indicate.

(5 marks)

(b) Momentum equation can be defined as the net force acting on the fluid element is equals to its mass times the acceleration of the element. Based on this definition, show that the momentum equation for compressible fluid flow is x-direction is

$$\rho(Du/Dt) = -(\delta p/\delta x) + (\delta \tau_{xx}/\delta x) + (\delta \tau_{yx}/\delta y) + (\delta \tau_{zx}/\delta z) + \rho g_x$$

(15 marks)

Q4 (a) Describe briefly the following terms;

(i) boundary layer thickness;

(ii) displacement thickness; and

(iii) momentum thickness.

(5 marks)

(b) A small aircraft has a wing area of 40 m^2, a lift coefficient of 0.4, and mass of 5000 kg. If the density of an air is 1.225 kg/m^3, determine the takeoff speed of this aircraft.

(5 marks)

(c) **Figure Q4(c)** shows the suspension of a ping-pong ball by an upward air jet. The density and velocity of air are 1.184 kg/m^3, 9.2 m/s respectively. Determine the drag coefficient of the ping-pong ball if the ball has mass of 3.1 g and diameter of 4.2 cm.

(10 marks)

PART B : ANSWER **ALL** QUESTIONS.

Q5 (a) Describe briefly the primary differences between fans, blowers and compressors in terms of pressure rise and volume flowrate.

(5 marks)

(b) A backward inclined blade centrifugal pump is used to pump water from a river into a tanker. The impeller inlet diameter, impeller exit diameter, blade thickness at inlet, blade thickness at exit, pump efficiency, blade angle at exit are 10 cm, 30 cm, 2 cm, 3 cm, 85 %, 55^{o} respectively. The angular velocity of the impeller is 900 rpm and mass flowrate is 7.1 kg/s. If the pump operates at its design flowrate, determine;

(i) absolute inlet velocity, V_1;

(ii) rotor tip velocity at exit, u_2;

(iii) absolute velocity at exit, V_2;

(iv) pump head;

(v) power deliver by the pump; and

(vi) power required to drive the pump.

(15 marks)

Q6 (a) Explain briefly how a shock wave is produced in a 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. If gas constant (R), specific heat at constant pressure (c_p) and specific heat ratio (k) of air are 0.287 kJ/kg.K, 1.4, 1.005 kJ/kg.K respectively, determine the critical temperature, pressure and density of air at 200kPa, 100^0C and 250 m/s

(6 marks)

-END OF QUESTIONS -

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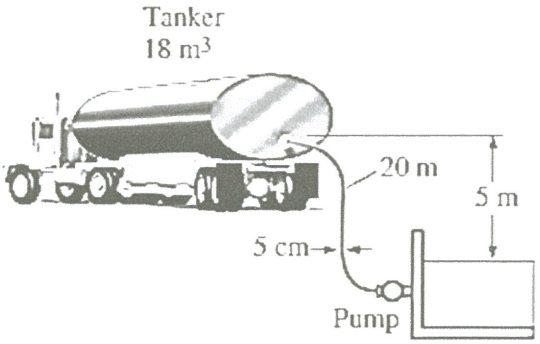

Figure Q2(b)

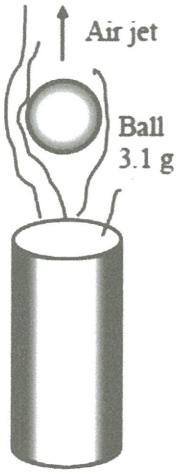

Figure Q4(c)

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List of Formula

1. $Re = \rho vD/\mu$
2. $Q = vA$
3. $Q = \pi D^4(\Delta p - \rho g l \sin\theta)/128\mu l$
4. $l_e/D = 0.06\ Re$ (laminar flow)
5. $l_e/D = 4.4\ (Re)^{1/6}$ (turbulent flow)
6. $h_L = flv^2/2gD$
7. $h_L = k_L v^2/2g$
8. $K_L = [1 - (D_1/D_2)^2]^2$ (sudden enlargement)
9. $f = 64/Re$ (laminar flow)
10. $1/f^{0.5} = -1.8 \log [(6.9/Re) + (\varepsilon/3.7D)^{1.1}]$ (turbulent flow)
11. $p_1/\rho g + v_1^2/2g + z_1 = p_2/\rho g + v_2^2/2g + z_2 + h_L + w - q$
12. $F_L = C_L \tfrac{1}{2} \rho U^2 A$
13. $F_D = C_D \tfrac{1}{2} \rho U^2 A$
14. $u = \omega r$
15. $Q = 2\pi r_1 b_1 V_{n1}$
16. $Q = 2\pi r_2 b_2 V_{n2}$
17. $H = (1/g)(u_2 V_{t2} - u_1 V_{t1})$
18. $P = \rho Q(u_2 V_{t2} - u_1 V_{t1})$
19. $T_0/T = 1 + V^2/2\, c_p T$
20. $p_0/p = (T_0/T)^{k/(k-1)}$
21. $p = \rho RT$
22. $p_0/p = (1 + [(k-1)/2]\, Ma^2)^{k/(k-1)}$
23. $T_0/T = 1 + [(k-1)/2]\, Ma^2$
24. $(\rho_0/\rho) = (1 + [(k-1)/2]\, Ma^2)^{1/(k-1)}$

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