Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	BFC10403
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE/JULY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Define the following terms,

(i) Pressure
(ii) Density
(iii) Specific weight
(iv) Specific gravity

(8 marks)

(b) If 1 m^3 of oil has a mass of 860 kg, determine the followings;

(i) Specific weight
(ii) Density
(iii) Specific gravity.

(6 marks)

(c) Calculate the minimum diameter of a glass tube if a capillary rise is not more than 0.25 mm and $\theta = 0$. Given, the surface tension = 0.075 N/m and specific weight of water , $\gamma = 9810$ kg/m^3 .

(6 marks)

Q2 (a) Determine the absolute pressure in unit kPa if barometer reads 60 kPa. Given that the barometer height at sea level is 740 mmHg and specific gravity of a mercury is 13.6.

(8 marks)

(b) Calculate the pressure difference (P_B-P_A) in double fluid manometer as shown in **Figure Q2(b).**

(12 marks)

Q3 (a) Water is discharging from a tank through a convergent-divergent mouthpiece as shown in **Figure Q3(a)**. Given the minimum diameter of the mouthpiece is 0.05 m and the head from the center-lined of the mouthpiece is 1.83 m. The atmospheric pressure is at 10 m of water. Assume that the losses are neglected and the exit of the mouthpiece is rounded.

(i) Determine the diameter at the exit if the absolute pressure at the minimum area is to be 2.44 m of water and calculate the discharge at that particular diameter.

(8 marks)

(ii) Calculate the discharge if the divergent part of the mouthpiece is removed.

(6 marks)

(b) Flow rate of mercury in a 150 mm diameter PVC pipe is 20 *l*/s. Given the specific gravity of mercury is 13.6, calculate the followings;

(i) Volume flow rate (m^3/s)
(ii) Mass flow rate (kg/s)
(iii) Weight flow rate (kN/s)

(6 marks)

Q4 Water flows at a rate of 0.5 m^3/s and rising through a 50°, contracting pipe bend. The diameter at the bend entrance is 700 mm and at the exit is 500 mm as shown in **Figure Q4.** If the pressure at the entrance to the bend is 200 kN/m^2, determine the magnitude and direction of the force exerted by the fluid on the bend. The exit of the bend is 0.4 m higher than the entrance and the bend has a volume of 0.2 m^3. Assume that the frictional losses can be neglected in the analysis.

(20 marks)

Q5 (a) A fluid flows through a galvanised iron pipe with length and diameter of 200 m and 400 mm respectively at a discharge of 55 *l*/s. Calculate the head loss due to fluid friction of pipe.
(Given ρ = 850 kg/m3, $\mu = 8.14 \times 10^{-2}$ Pa.s, 1 m^3 = 1000 *l*).

(7 marks)

(b) A fluid flows in series of pipe with a flow rate of 0.04 m^3/s. Given that,

D_1 = 30 cm	D_2 = 20 cm	D_3 = 40 cm
L_1 = 2000 m	L_2 = 1000 m	L_3 = 2000 m
f_1 = 0.022 m	f_2 = 0.025 m	f_3 = 0.021 m
Z_a = 20 m, Z_b = 25 m, Zc = 32.5 m, Z_d = 37.5 m		

Determine the pressure and total head at points A, B, C and D for the pipe series shown in **Figure Q5(b).** Assume fully turbulent flow for all cases and the pressure head at point A is 40 m of water.

(13 marks)

Q6 (a) Describe the following terms,

(i) Dynamic similarity
(ii) Kinematic similarity
(iii) Geometric similarity.

(9 marks)

(b) Assume that the drag force, F, exerted on a body is a function of the following parameters which include fluid density (ρ), fluid viscosity (μ), diameter (d), and velocity (v). Prove that the drag force can be expressed as,

$$F = d^2 \mu^2 \rho \phi(\text{Re})$$

where ϕ is some unknown function and Re is the Reynolds number.

(11 marks)

- END OF QUESTIONS -

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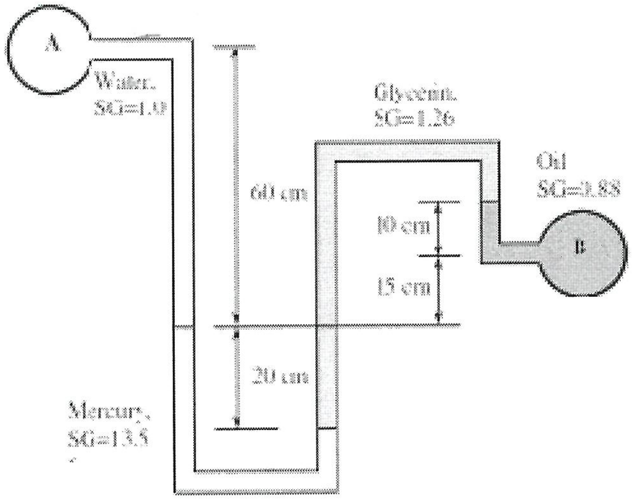

FIGURE Q2(b)

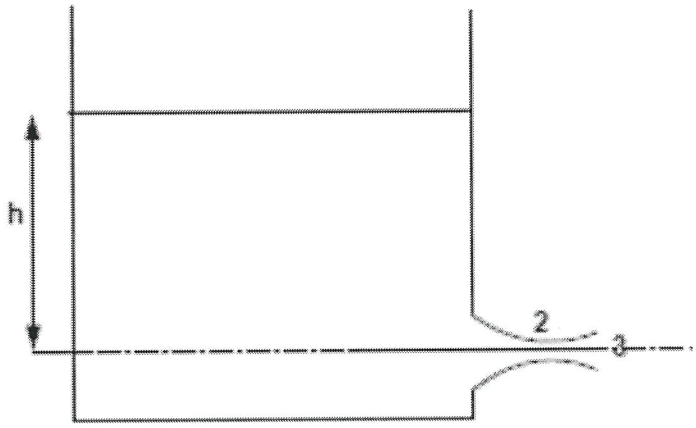

FIGURE Q3(a)

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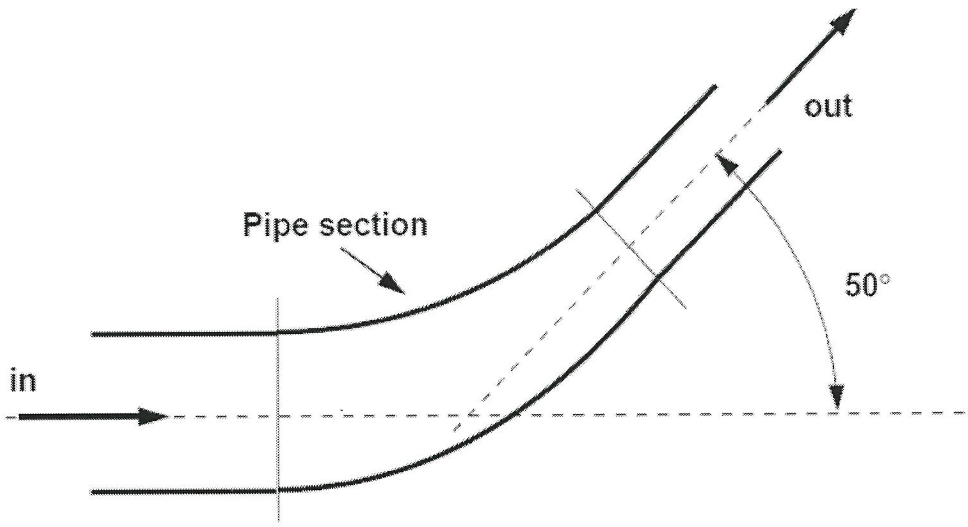

FIGURE Q4

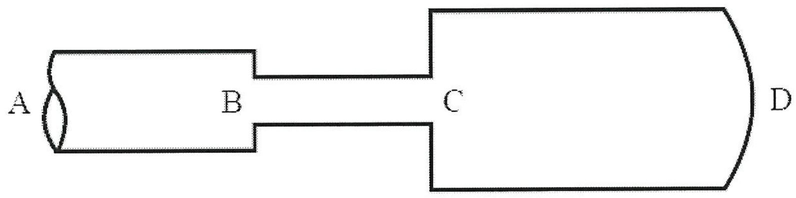

FIGURE Q5(b)

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Table Q6(b): Dimensionless and Quantity for Fluid Mechanics

Quantity	Symbol	Dimension
FUNDAMENTAL		
Mass	m	M
Length	L	L
Time	t	T
GEOMETRIC		
Area	A	L^2
Volume	V	L^3
Angle	θ	$M^0L^0T^0$
First area moment	Ax	L^3
Second area moment	Ax^2	L^4
Strain	e	L^0
DINAMIC		
Force	F	MLT^{-2}
Weight	W	MLT^{-2}
Specific weight	γ	$ML^{-2}T^{-2}$
Density	ρ	ML^{-3}
Pressure	P	$ML^{-1}T^{-2}$
Shear stress	τ	$ML^{-1}T^{-2}$
Modulus of elasticity	E, K	$ML^{-1}T^{-2}$
Momentum	M	MLT^{-1}
Angular momentum		ML^2T^{-1}
Moment of momentum		ML^2T^{-1}
Force moment	T	ML^2T^{-2}
Torque	T	ML^2T^{-2}
Energy	E	L
Work	W	ML^2T^{-2}
Power	P	ML^2T^{-3}
Dynamic viscocity	μ	$ML^{-1}T^{-1}$
Surface tension	σ	MT^{-2}
KINEMATIC		
Linear velocity	U,v,u	LT^{-1}
Angular velocity	ω	T^{-1}
Rotational speed	N	T^{-1}
Acceleration	a	LT^{-2}
Angular acceleration	α	T^{-2}
Gravity	g	LT^{-2}
Discharge	Q	L^3T^{-1}
Kinematic viscosity	υ	L^2T^{-1}
Stream function	ψ	L^2T^{-1}
Circulation	Γ	L^2T^{-1}

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COMPLIMENTARY EQUATIONS:

$h = \dfrac{2\sigma_s}{\rho g R}\cos\phi$ $y_p = y_c + \dfrac{I_{xxC}}{[y_c + P_o/(\rho g \sin\theta)]A}$

$\mathrm{Re} = \dfrac{\rho V D}{\mu} = \dfrac{DV}{\nu}$ $\mathrm{F_r} = \dfrac{V}{\sqrt{gL}}$ $h_f = f\left(\dfrac{L}{D}\right)\dfrac{V^2}{2g}$

$H = \dfrac{P}{\gamma} + z + \dfrac{V^2}{2g}$ $h_k = k\dfrac{v^2}{2g}$ $F = \sqrt{F_x^{\,2} + F_y^2}$ $F_y = \rho g V$

$F_x = \rho g A\bar{x}$ $\phi = \tan^{-1}\dfrac{F_y}{F_x}$ $BM = \dfrac{I}{V}$ $\mathrm{W = mg}$

$\mathrm{R} = \rho g \mathrm{V}$ $\rho = \dfrac{M}{V}$ $P = \rho g h$ $\gamma = \rho g$

$V = \sqrt{2gh}$ $h_L = H - \dfrac{V_a}{2g}$ $\mathrm{Q = AV}$ $C_d = C_c x C_V$

$Q = C_d a\sqrt{2gH}$ $C_v = \dfrac{x}{\sqrt{4yH}}$ $\dot{m} = \rho A V$ $C_V = \dfrac{V_a}{V}$

$\mathrm{R_X} = \dot{m}(V_{X1} - V_{X2})$ $\mathrm{R_Y} = \dot{m}(V_{Y1} - V_{Y2})$ $f = \dfrac{64}{\mathrm{Re}}$