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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	BFC10403
PROGRAMME	:	BACHELOR OF CIVIL ENGINEERING WITH HONOURS
EXAMINATION DATE	:	JUNE 2015 / JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

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Q1 (a) A 0.8-mm-diameter glass tube is inserted into kerosene at 20°C in a cup. The surface tension is 0.028 N/m. The contact angle of kerosene with a glass surface is approximately 26°. Determine the capillary rise of kerosene in the tube. Given the density of kerosene, $\rho = 820$ kg/m^3.

(4 marks)

(b) Describe with the aid of sketches the capillary effect and how is it affected by the contact angle.

(8 marks)

(c) Determine the specific weight, density, specific volume and specific gravity of certain liquid. The volume and weight are 8.2 m^3 and 72 kN, respectively.

(13 marks)

Q2 (a) Express Pascal's Law, and give **two (2)** real-world examples of it.

(6 marks)

(b) Consider a large portion of a cubic ice block (0.4-m×0.4-m×3-m) floating in seawater as shown in **FIGURE Q2(b).** The specific gravities of ice and water are 0.92 and 1.025, respectively.

(i) If a 25-cm-high portion of the cubic ice block extends above the surface of the water, determine the height (h) of the ice block below the surface.

(ii) Calculate the bouyant force if the ice block is completely immersed in seawater.

(7 marks)

(c) A 3-m high, 6-m-wide rectangular gate is hinged at the top edge at A and is restrained by a fixed ridge at B as shown in **FIGURE Q2(c).** Determine the hydrostatic force exerted on the gate by the 5-m-high water and the location of the pressure center.

(12 marks)

Q3 (a) Starting with the Bernoulli and Continuity equations, show that the following expression gives the discharges measured by a venturimeter as shown in **FIGURE Q3(a)**.

(7 marks)

(b) A horizontal venturimeter is used to measure the flow of water in a 200 mm diameter pipe. The throat diameter of the venturimeter is 80 mm and the discharge coefficient is 0.85. If the pressure difference between the two measurement points is 10 cm of mercury, calculate the average velocity in the pipe. Assume the relative density of mercury is 13.6.

(8 marks)

(c) The velocity of the water flowing in the same pipe is also measured using a pitot-static tube located centrally in the flow as shown in **FIGURE Q3(c)**. If the height measured on the attached manometer is, h= 60 mm and the relative density of the manometer fluid is 1.45, determine the velocity of the water. Calculate the velocity of the water.

(10 marks)

Q4 (a) Define the following:

(i) Hydraulic grade line

(ii) Energy grade line

(5 marks)

(b) Explain minor losses in pipe flow and defined the minor loss coefficient K_L .

(4 marks)

(c) **FIGURE Q4(c)** shows a water drained from an open large reservoir using two horizontal plastic pipes connected in series. The first pipe is 20 m long and has a 10 cm diameter, while the second pipe is 35 m long and has a 4 cm diameter. The water level in the reservoir is 18 m above the centerline of the pipe. The pipe entrance is sharp-edged, and the contraction between the two pipes is sudden. Determine the discharge rate of water from the reservoir. (Given: The loss coefficient of sharp-edged entrance is K_L = 0.5 and it is 0.46 for the sudden contraction.The friction factor is 0.002 for both pipes.)

(16 marks)

Q5 (a) Define the difference between dimension and unit and give **three (3)** examples of each.

(5 marks)

(b) Explain briefly geometry and kinematic similitude

(6 marks)

(c) The variables involved for the motion of a floating vessel through water are the drag force F_D, the speed V, the length L, the fluid density ρ, the viscosity μ and the acceleration due to gravity g. Using Rayleigh's method, obtain an expression for the drag force.

(14 marks)

- END OF QUESTION -

FINAL EXAMINATION

SEMESTER/SESSION : SEM II 2014/15 PROGRAMME : BFF
COURSE NAME : FLUID MECHANICS COURSE CODE: BFC 10403

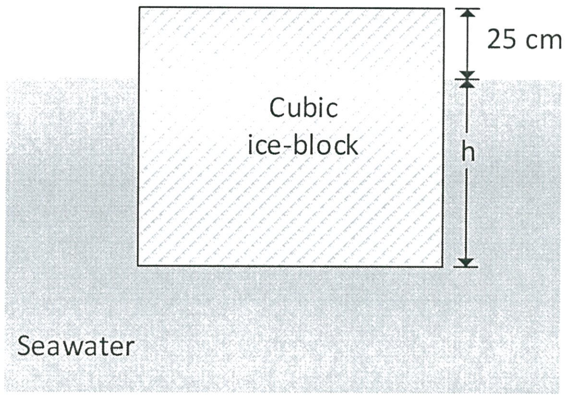

FIGURE Q2(b)

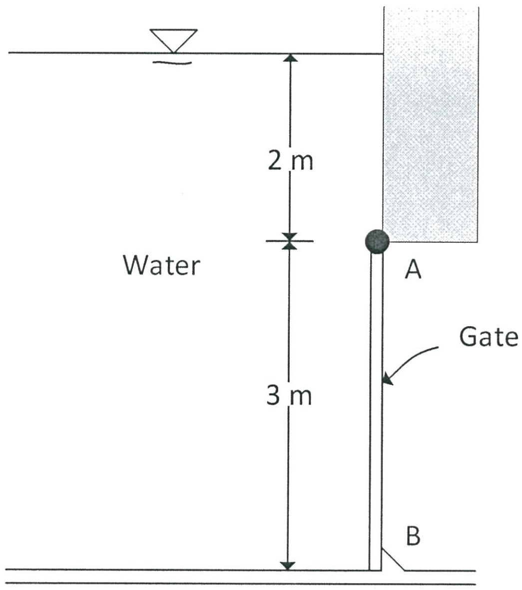

FIGURE Q2(c)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2014/2015
COURSE NAME : FLUID MECHANICS

PROGRAMME : BFF
COURSE CODE: BFC 10403

$$Q = C_d A_1 A_2 \sqrt{\frac{2g\left(\frac{P_1 - P_2}{\rho g} + z_1 - z_2\right)}{A_1^2 - A_2^2}}$$

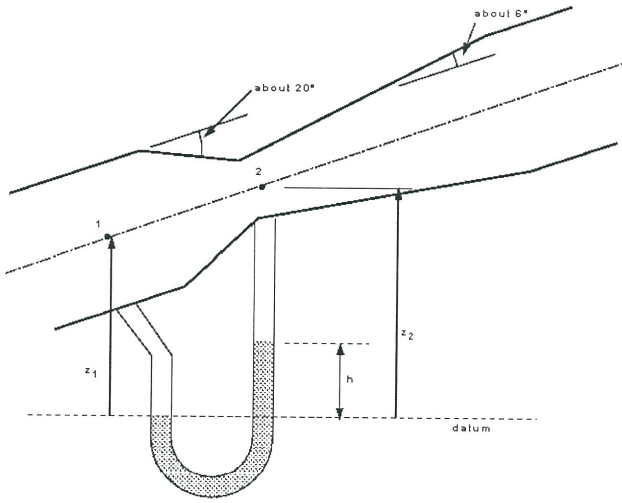

FIGURE Q3(a)

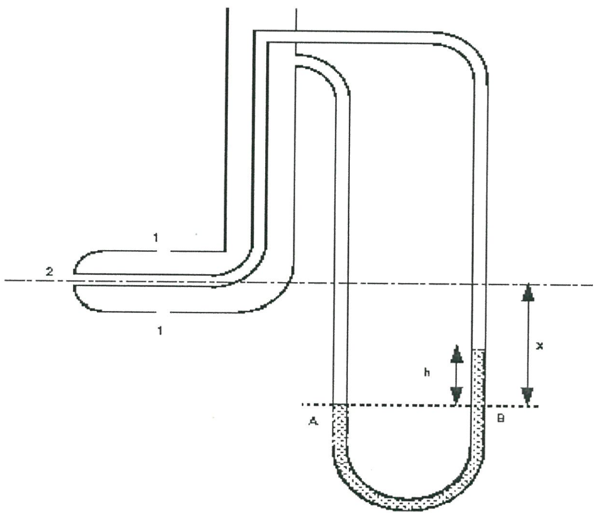

FIGURE Q3(c)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II /2014/2015
COURSE NAME : FLUID MECHANICS

PROGRAMME : BFF
COURSE CODE: BFC 10403

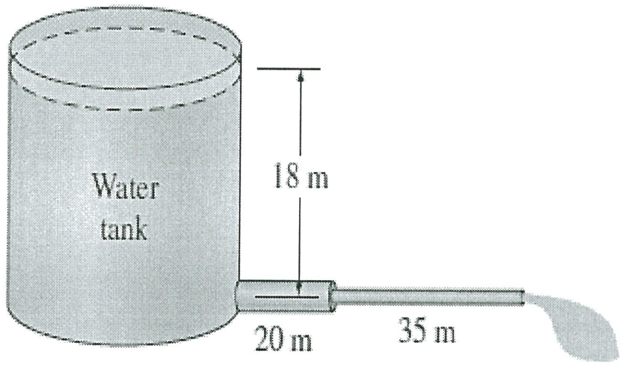

FIGURE Q4(c)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II /2014/2015 PROGRAMME : BFF
COURSE NAME : FLUID MECHANICS COURSE CODE: BFC 10403

Table 1: Dimensionless and Quantity for Fluid Mechanics

Kuantiti	Quantity	Simbol	Dimensi
ASAS	**FUNDAMENTAL**		
Jisim	Mass	m	M
Panjang	Length	L	L
Masa	Time	t	T
GEOMETRI	**GEOMETRIC**		
Luas	Area	A	L^2
Isipadu	Volume	V	L^3
Sudut	Angle	θ	$M^0L^0T^0$
Momen luas pertama	First area moment	Ax	L^3
Momen luar kedua	Second area moment	Ax^2	L^4
Keterikan	Strain	e	L^0
DINAMIK	**DINAMIC**		
Daya	Force	F	MLT^{-2}
Berat	Weight	W	MLT^{-2}
Berat tentu	Specific weight	γ	$ML^{-2}T^{-2}$
Ketumpatan	Density	ρ	ML^{-3}
Tekanan	Pressure	P	$ML^{-1}T^{-2}$
Tegasan ricih	Shear stress	τ	$ML^{-1}T^{-2}$
Modulus keanjalan	Modulus of elasticity	E, K	$ML^{-1}T^{-2}$
Momentum	Momentum	M	MLT^{-1}
Momentum sudut	Angular momentum		ML^2T^{-1}
Momen momentum	Moment of momentum		ML^2T^{-1}
Momen daya	Force moment	T	ML^2T^{-2}
Daya kilas	Torque	T	ML^2T^{-2}
Tenaga	Energy	E	L
Kerja	Work	W	ML^2T^{-2}
Kuasa	Power	P	ML^2T^{-3}
Kelikatan dinamik	Dynamic viscocity	μ	$ML^{-1}T^{-1}$
Tegangan permukaan	Surface tension	σ	MT^{-2}
KINEMATIK	**KINEMATIC**		
Halaju lelurus	Linear velocity	U,v,u	LT^{-1}
Halaju sudut	Angular velocity	ω	T^{-1}
Halaju putaran	Rotational speed	N	T^{-1}
Pecutan	Acceleration	a	LT^{-2}
Pecutan sudut	Angular acceleration	α	T^{-2}
Graviti	Gravity	g	LT^{-2}
Kadar alir	Discharge	Q	L^3T^{-1}
Kelikatan kinematik	Kinematic viscosity	υ	L^2T^{-1}
Fungsi arus	Stream function	ψ	L^2T^{-1}
Putaran	Circulation	Γ	L^2T^{-1}
Pusaran	Vorticity	Ω	T^{-1}

FINAL EXAMINATION

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COMPLIMENTARY EQUATIONS

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

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

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

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

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

$V = \sqrt{2gh}$ $h_L = H - \frac{V_a}{2g}$ $\mathrm{F_r} = \frac{V}{\sqrt{gL}}$ $C_d = C_c x C_V$

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

$\mathrm{R_X} = \dot{m}(V_{X1} - V_{X2})$ $\mathrm{R_Y} = \dot{m}(V_{Y1} - V_{Y2})$ $R = \sqrt{R_X^{\,2} + R_Y^{\,2}}$