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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	: FLUID MECHANICS
COURSE CODE	: BFC 10403
PROGRAMME CODE	: BFF
EXAMINATION DATE	: JULY/AUGUST 2023
DURATION	: 3 HOURS
INSTRUCTION	: 1.ANSWER ALL QUESTIONS 2.THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** 3.STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

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

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Q1 (a) Describe with the aid of sketches the capillary effect and its affect by the contact angle.

(6 marks)

(b) A tennis ball has fallen into the drain and its floats on the water surface. Explain briefly with the aid of diagram, the force involved in this phenomenon.

(6 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.

(8 marks)

Q2 (a) A manometer is attached to a tank containing three different fluids, as shown in **Figure Q2(a)**. Determine the difference in elevation of the mercury column in the manometer, x.

(5 marks)

(b) **Figure Q2(b)** shows a brass cube with 152.4 mm on a side and weights 298.2 N. In order to hold this cube in equilibrium under water, a light foam buoy was attached. If the foam weighs 707.3 N/m^3, estimate the minimum required volume of the buoy.

(7 marks)

(c) Referring to **Figure Q2(c)**, determine the magnitude of the resultant force on the indicated area and the location of the center of pressure.

(8 marks)

Q3 (a) Explain briefly the continuity equation with the aid of diagram.

(4 marks)

(b) Define EL and HGL and discuss further with illustration of sketch.

(4 marks)

(c) **Figure Q3(c)** shows a necked-down section in venturi meter to develops a low throat pressure which can aspirate fluid upward from a reservoir. Using Bernoulli's equation with no losses, derive an expression for the velocity V1 (in terms of h, D_1, D_2, and g) which is just sufficient to bring reservoir fluid into the throat.

(6 marks)

(d) **Figure Q3(d)** shows a pressurized tank of water has a 10-cm-diameter orifice at the bottom, where water discharges to the atmosphere. The water level is 3 m above the outlet. The tank air pressure above the water level is 300 kPa while the atmospheric pressure is 100 kPa. Neglecting frictional effects, calculate the initial discharge rate of water from the tank.

(6 marks)

Q4 (a) Briefly describe about minor losses in pipes and give **TWO (2)** contributors to the minor losses in pipes.

(4 marks)

(b) A smooth pipe with a constant diameter of 0.20 m carries water at a temperature of 10°C. The pressure in pipe at section 1 and section 2 is 50 kPa and 20 kPa, respectively. Section 1 is located 2 m lower than section 2. Determine the head loss in the pipe.

(8 marks)

(c) **Figure Q4(c)(i)** shows the system consists of 1200 m of 5 cm cast-iron pipe, two 45° and four 90° flanged long-radius elbows, a fully open flanged globe valve, and a sharp exit into a reservoir. Calculate gage pressure at point 1 to deliver 0.005 m3/s of water into the reservoir if elevation at point 1 is 400m. Given μ = 0.001 kg/m·s.; 45o long-radius elbow, k = 0.2; 90° long-radius elbow, k=0.3; Open flanged globe valve, k=8.5; submerged exit, k=1.0. [Please use: Moody Chart diagram in **Figure Q4 (c)(ii)** and attach it together with your answer script].

(8 marks)

Q5 (a) List and discuss **TWO (2)** non-dimensional parameters.

(6 marks)

(b) Calculate discharge for spillway prototype if model with size ratio of 1:10 has a discharge of 1.05 m^3/s. If a flood phenomena takes 8 hours to occur using spillway prototype, determine the time taken for a model by using Froude number.

(6 marks)

(c) Analyse shear stress, τ_o on the walls of triangular channel which depends on the vertex angle, θ, depth of flow, y, density, ρ and gravity, g. Obtain an expression in dimensionless equation using Buckingham Theorem if repeating variables are density, gravity and depth of flow by referring to **Table Q5(c)**.

(8 marks)

-END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER / SESSION : SEM II 2022/2023
COURSE NAME : FLUID MECHANICS
PROGRAMME CODE : BFF
COURSE CODE : BFC 10403

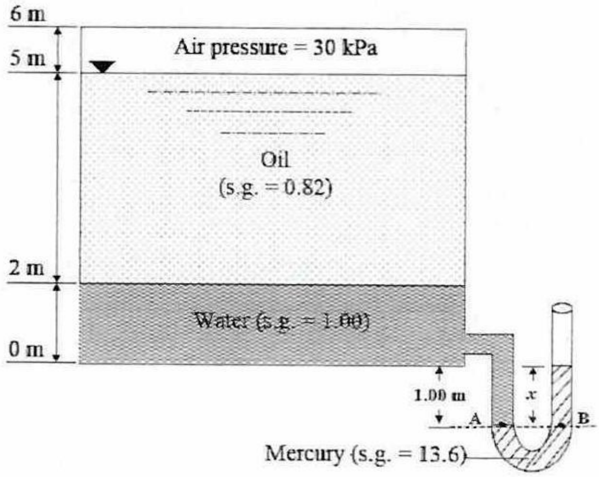

Figure Q2(a)

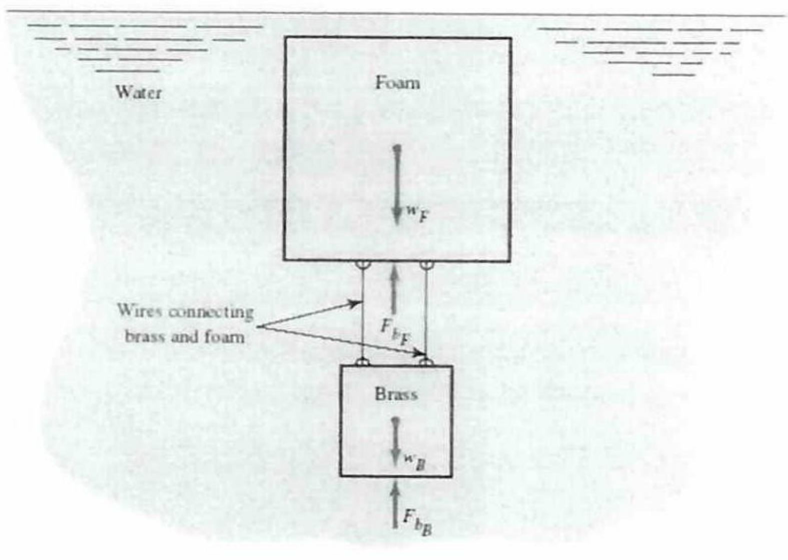

Figure Q2(b)

FINAL EXAMINATION

SEMESTER / SESSION	: SEM II 2022/2023	PROGRAMME CODE	: BFF
COURSE NAME	: FLUID MECHANICS	COURSE CODE	: BFC 10403

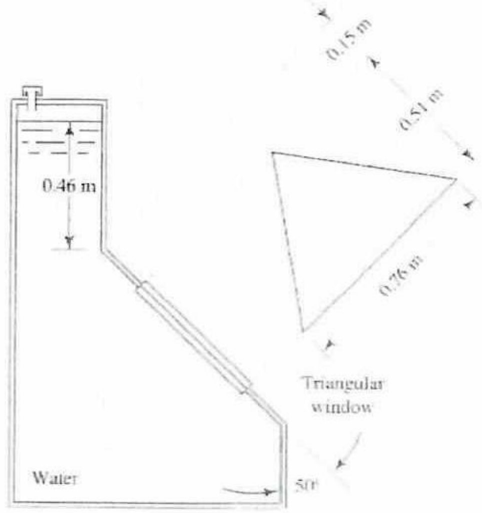

Figure Q2(C)

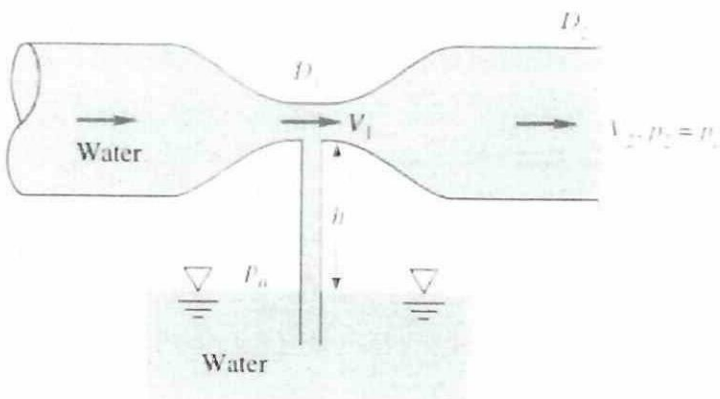

Figure Q3(c)

FINAL EXAMINATION

SEMESTER / SESSION	: SEM II 2022/2023	PROGRAMME CODE	: BFF
COURSE NAME	: FLUID MECHANICS	COURSE CODE	: BFC 10403

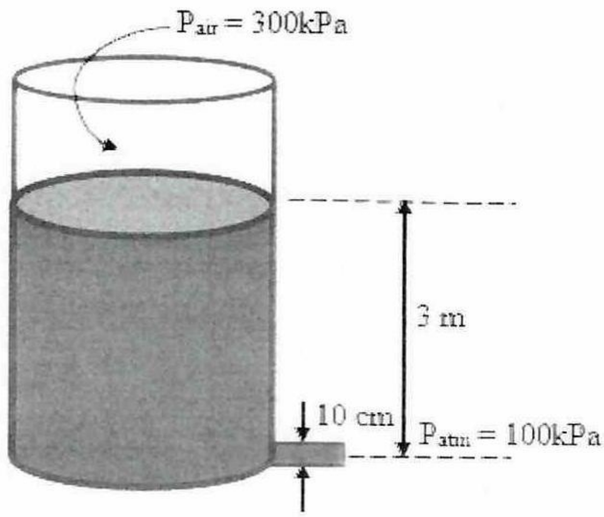

Figure Q3(d)

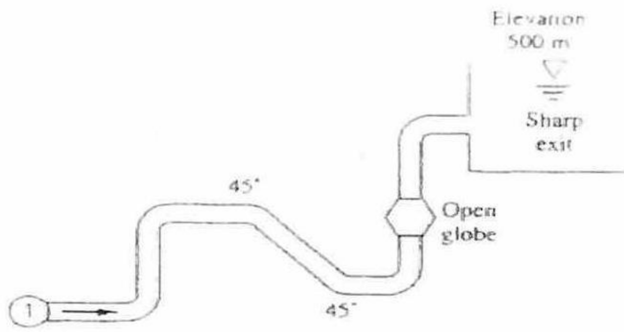

Figure Q4(c)(i)

FINAL EXAMINATION

SEMESTER / SESSION : SEM II 2022/2023
COURSE NAME : FLUID MECHANICS

PROGRAMME CODE : BFF
COURSE CODE : BFC 10403

The Moody Chart

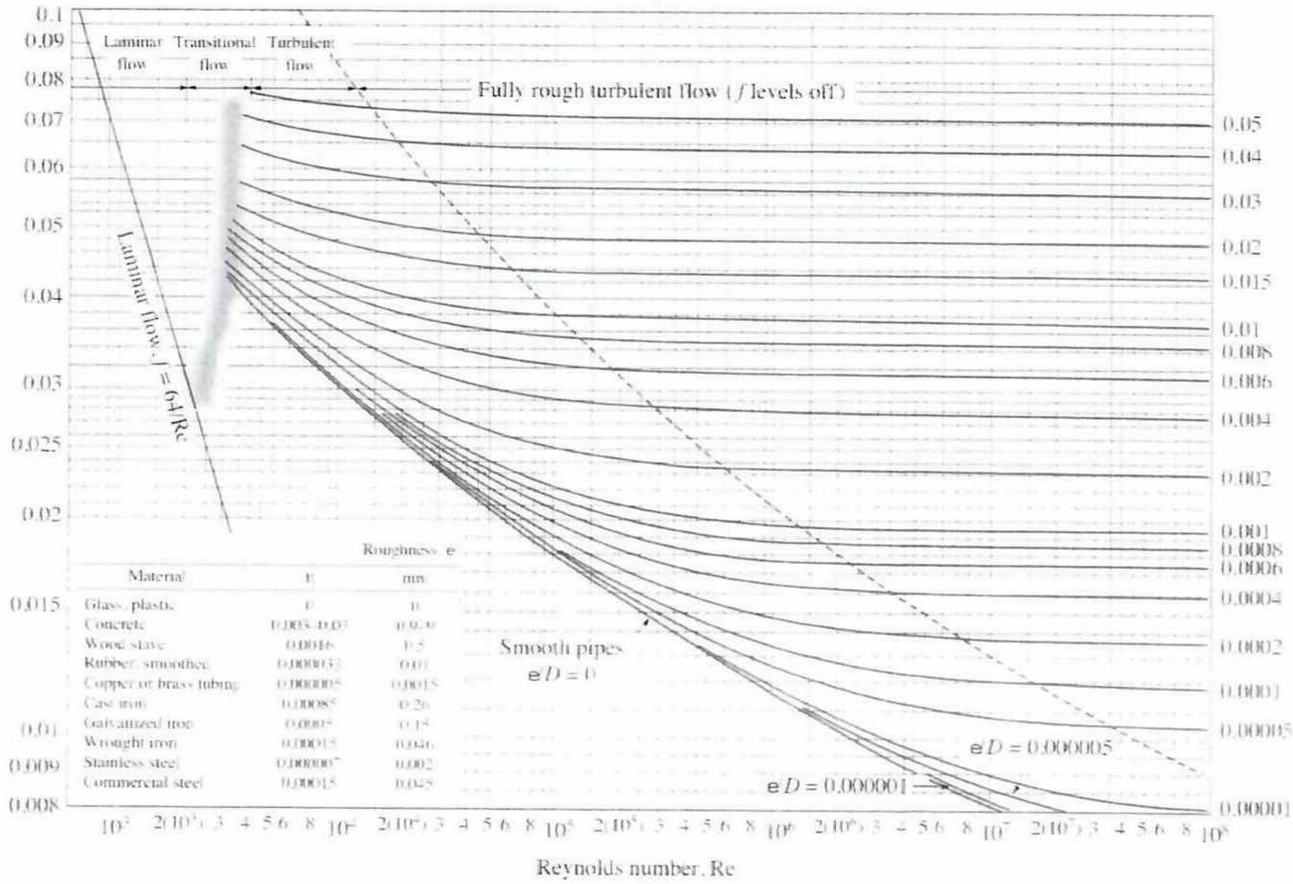

Figure Q4(c)(ii)

FINAL EXAMINATION

SEMESTER / SESSION : SEM II 2022/2023
COURSE NAME : FLUID MECHANICS
PROGRAMME CODE : BFF
COURSE CODE : BFC 10403

Table Q5(c)

Quantity	Symbol	Dimension	Froude
FUNDAMENTAL			
Mass	m	M	
Length	L	L	L_r
Time	t	T	$L_r^{1/2}g^{-1/2}$
GEOMETRIC			
Area	A	L^2	
Volume	V	L^3	L_r^2
Angle	θ	$M^0L^0T^0$	L_r^3
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}	$L_r^{1/2}g^{1/2}$
Angular velocity	ω	T^{-1}	
Rotational speed	N	T^{-1}	
Acceleration	a	LT^{-2}	g_r
Angular acceleration	α	T^{-2}	
Gravity	g	LT^{-2}	
Discharge	Q	L^3T^{-1}	$L_r^{5/2}g^{1/2}$
Kinematic viscosity	υ	L^2T^{-1}	
Stream function	ψ	L^2T^{-1}	
Circulation	Γ	L^2T^{-1}	

FINAL EXAMINATION

SEMESTER / SESSION : SEM II 2022/2023
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LIST OF FORMULA

$$h_f = \frac{32\mu LV}{\rho g D^2}$$

$$Re = \frac{\rho VD}{\mu} = \frac{DV}{\nu}$$

$$Fr = \frac{V}{\sqrt{gD}}$$

$$h_m = k\frac{V^2}{2g}$$

$$Q = \frac{\Delta P \pi D^4}{128 L\mu}$$

$$H = \frac{P}{\gamma} + z + \frac{V^2}{2g}$$

$$F = \rho Q \Delta V$$

$$h_f = \frac{fLV^2}{2gD}$$

$$MG = MB - BG$$

$$MB = \frac{I_{xx}}{V}$$

$$P = \rho g h$$

$$Q = VA$$

$$I_{xx} = \frac{bh^3}{12}$$

$$Q = \frac{(\Delta P - \rho g L \sin\theta)\pi D^4}{128 L\mu}$$