Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION (ONLINE) SEMESTER II SESSION 2019/2020

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	BFC10403
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2020
DURATION	:	6 HOURS
INSTRUCTION	:	1) ANSWER **ALL** QUESTIONS IN **PART A** 2) ANSWER ANY **TWO (2)** QUESTIONS FROM **PART B**

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

PART A: ANSWER ALL QUESTIONS

Q1 (a) For each statement, choose whether the statement is true or false and discuss your answer briefly.

(i) Kinematic similarity is a necessary and sufficient condition for dynamic similarity.
(ii) Geometric similarity is a necessary condition for dynamic similarity.
(iii) Geometric similarity is a necessary condition for kinematic similarity.
(iv) Dynamic similarity is a necessary condition for kinematic similarity

(8 marks)

(b) Explain with **THREE (3)** examples of prototypes and their corresponding models flow that have geometric similarity, but not kinematic similarity, even though the Reynolds numbers match.

(9 marks)

(c) Write the primary dimensions of each of the following variables: (i) moment of inertia, I; (ii) modulus of elasticity, E, also called Young's modulus; (iii) strain; (iv) stress (v) Finally, show that the relationship between stress and strain (Hooke's law) is a dimensionally homogeneous equation. (Refer **Table Q1 (c)**).

(8 marks)

Q2 (a) Define:

(i) Major head loss (h_f)

(1 mark)

(ii) Energy line (EL)

(1 mark)

(iii) Moody chart

(2 marks)

(b) With the aid of sketch, compare discharge and head loss of pipe in series and parallel.

(5 marks)

(c) A 250 mm diameter of cast iron pipe flows 39.3 L/s of SAE 10 oil along 500 m length. Given: dynamic viscosity, μ and density, ρ of SAE 10 oil are 1.04×10^{-1} Ns/m^2 and 917 kg/m^3 respectively. By assuming the flow is laminar, determine energy head and pressure loss due to pipe friction using Hagen-Poiseuille equation and friction factor, f.

(7 marks)

(d) Three pipes *A*, *B* and *C* are interconnected as shown in **Figure Q2 (d)** and the pipe characteristics are tabulated in **Table Q2 (d)**. Calculate flowrate at in each pipe, neglect minor losses.

(9 marks)

PART B – ANSWER ANY TWO (2) QUESTIONS

Q3 (a) Define the following fluid properties:

(i) Bulk modulus

(2 marks)

(ii) Vapor pressure

(2 marks)

(b) By referring to **Figure Q3 (b)**, explain in detail the phenomena of surface tension that are happening in:

(i) Liquid molecules A and B

(2 marks)

(ii) Liquid molecules C and D

(3 marks)

(c) (i) Given surface tension σ = 0.0735 N/m and pressure $p = \dfrac{2\pi r\sigma}{\pi r^2}$, determine the pressure inside a 2 mm diameter air bubble .

(4 marks)

(ii) Explain briefly the effects of temperature on the viscosity of a liquid.

(3 marks)

(d) The values of surface tension for water and mercury in contact with air are 0.0735N/m and 0.5100N/m respectively. The contact angle for water is $\Theta = 0^{o}$ and for mercury $\Theta = 130^{o}$. Given, specific weight of water, $\gamma_{water} = 9.81\text{x } 10^3$ N/m^3 and specific weight mercury, $\gamma_{mercury} = 132.8\text{x } 10^3$ N/m^3. Calculate the capillary effect in a glass tube of 4 mm diameter, when immersed in water and mercury.

(9 marks)

Q4 (a) Describe **TWO (2)** type of manometers

(4 marks)

(b) With aid of diagram, explain briefly the hydrostatic force and buoyancy.

(5 marks)

(c) **Figure Q4 (c)** shows a homogenous 1.2 m wide and 3 m long rectangular gate is held in place by a horizontal flexible cable. Water acts against gate which is hinged at point **A.** Determine magnitude and location of resultant force.

(7 marks)

(d) A solid block of woods floats in water with 40 mm projection above the water surface. When places in glycerine of specific gravity 1.35, the solid block projects 70 mm above the surface of that liquid.

(i) Calculate the specific gravity of wood

(7 marks)

(ii) What is happening if the wood is replacing by rubber in the tank filled with water (specific gravity is 1.15).

(2 marks)

Q5 (a) Define the principle of Bernoulli's Theorem and state the three major assumptions used in the derivation of the Bernoulli equation.

(4 marks)

(b) With aid of diagram, discuss briefly the momentum equation

(5 marks)

(c) A fire hose has a 12.5-cm inside diameter and is flowing at 2.27 m^3/min. The flow exits through a nozzle contraction at a diameter D_n. For steady flow, determine diameter D_n to create an exit velocity of 25 m/s.

(7 marks)

(d) **Figure Q5 (d)** shows the water passage with 3 m wide normal to the plane of the structure. Calculate and provide the direction of the horizontal force acting on the structure.

(9 marks)

– END OF QUESTIONS –

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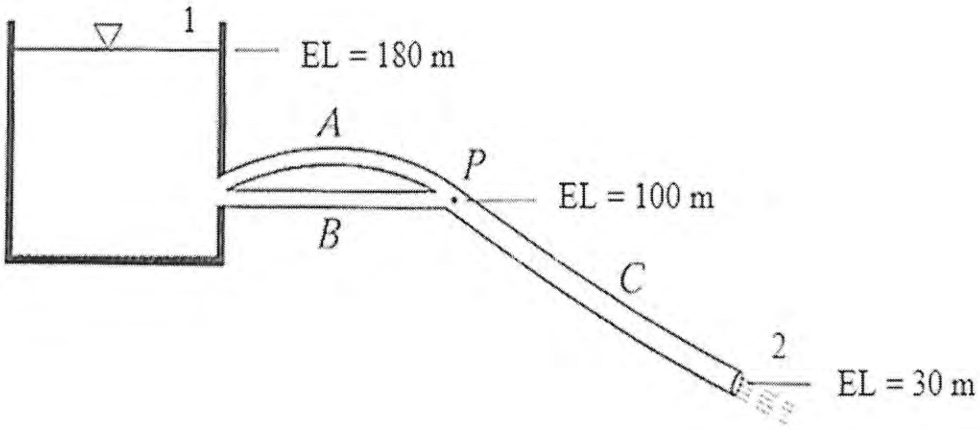

FIGURE Q2 (d)

TABLE Q2 (d)

Pipe	D (cm)	L (m)	f
A	5	2000	0.020
B	3	1600	0.032
C	7	4000	0.024

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TABLE Q1 (c): Dimensionless and Similitude 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}
Fnergy	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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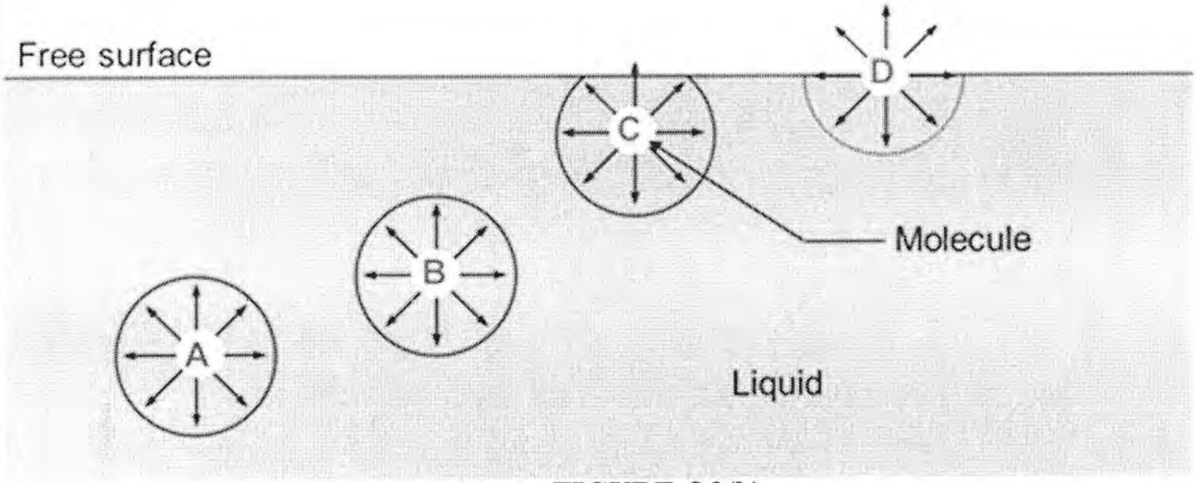

FIGURE Q3(b)

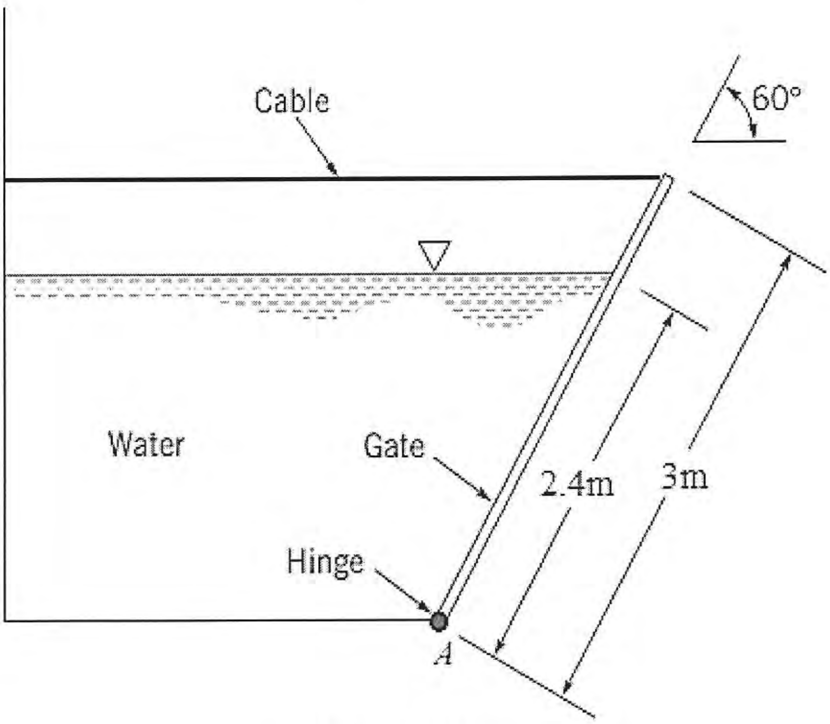

FIGURE Q4 (c)

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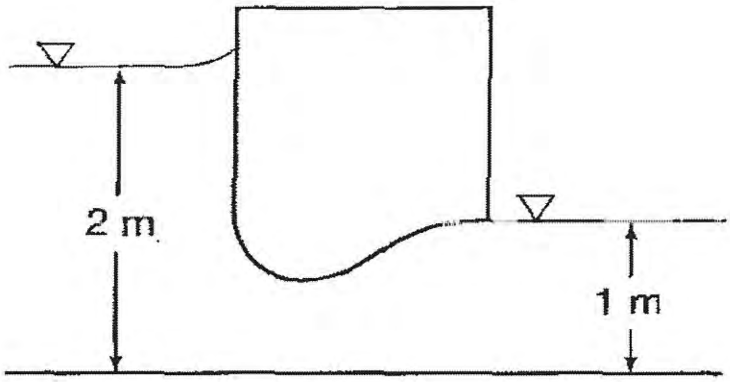

FIGURE Q5 (d)

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LIST OF FORMULA

$$h_f = \frac{32\mu LV}{\rho g D^2} \qquad Re = \frac{\rho VD}{\mu} = \frac{DV}{\nu} \qquad Fr = \frac{V}{\sqrt{gD}} \qquad h_m = k\frac{V^2}{2g}$$

$$Q = \frac{\Delta P \pi D^4}{128 L\mu} \qquad H = \frac{P}{\gamma} + z + \frac{V^2}{2g} \qquad F = \rho Q \Delta V \qquad h_f = \frac{fLV^2}{2gD}$$

$$MG = MB - BG \qquad MB = \frac{I_{xx}}{V} \qquad P = \rho g h \qquad Q = VA$$

$$I_{xx} = \frac{bh^3}{12} \qquad Q = \frac{(\Delta P - \rho g L \sin\theta)\pi D^4}{128 L\mu} \qquad h = \frac{2\sigma_s}{\rho g R}\cos\phi$$