Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESI 2021/2022

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	BFC 10403
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JANUARY / FEBRUARY 2022
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS. 2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **CLOSE BOOK**.

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) With the aid of the diagram, define the pascal law to the triangular prism which consists a fluid at the rest and exerted a pressure at x, y and z plane.
(4 marks)

(b) Relate the capillary action to the concept of cohesive and adhesive forces by demonstrating the derivation of capillary rise from the surface tension forces and weight of water column. Provide a sketch to aid the derivation.
(5 marks)

(c) A vertical gate of height 5 m and width of 3 m opposes the water at one of its sides. The deep of the water in the reservoir is 20 m. Determine the pressure and the force acted at the centroid of the gate
(7 marks)

(d) A 3 m high, 6 m wide rectangular gate is hinged at the top edge at A an is restrained by a fixed ridge at B as shown in **Figure Q1(d).** Calculate the hydrostatic force exerted on the gate by the 5 m high water and determine the location of the pressure center.
(9 marks)

Q2 (a) Describe **FOUR (4)** basic assumptions upon the application of Bernoulli equation.
(4 marks)

(b) Relate how the momentum equations may be derived using fluid parameters.
(5 marks)

(c) Water with density of 998 kg/m^3 flows through an inclined pipe with diameter of 8 cm. At section A, pressure and elevation level are 175 kPa and 23.5 m, respectively. Meanwhile, pressure and elevation level at section B are 255 kPa, and 8.5 m, respectively. Determine the head loss and show direction of flowing water.
(7 marks)

(d) Flow occurs over the spillway of constant section as shown in **Figure Q2(d).** Given that y_1, = 4.2 m and y_2 = 0.7 m, calculate the horizontal force on the spillway per meter of spillway width perpendicular to the spillway section.
(9 marks)

Q3 (a) Define the major losses and minor losses in pipe flow.

(4 marks)

(b) Discuss why the friction factor is independent to very large Reynolds numbers.

(5 marks)

(c) **Figure Q3(c)** shows a 6 cm diameter horizontal water pipe expands gradually to a 9 cm diameter pipe. The walls of the expansion section are angled 60° from the horizontal. The average velocity and pressure of water before the expansion section are 7 m/s and 150 kPa, respectively. Determine the head loss in the expansion section and the pressure in the larger diameter pipe.
(Given: Loss coefficient for gradual expansion of $\theta = 60^{\circ}$ included angle is K_L=0.07)

(7 marks)

(d) A 2.5 m diameter of galvanised iron pipe was used to flow water in horizontal axis at at rate of 40 m^3/s and cause 2 m of energy head loss. Calculate the length of pipe if $\nu = 1 \times 10^{-5}$ m^2/s.
(Note: Please attach the **Figure Q3(d)** *Moody diagram that has been marked with your answer together with the answer script)*

(9 marks)

Q4 (a) Define a Dimension and a Unit. State **TWO (2)** examples of Dimension and Unit.

(4 marks)

(b) With the aid of sketch, discuss the differences of functions of pipe in series and parallel.

(5 marks)

(c) Two pipes of identical length and material are connected in parallel. The diameter of pipe *A* is twice the diameter of pipe *B*. Assuming the friction factor to be the same in both cases and disregarding minor losses, determine the ratio of the flow rates in the two pipes.

(7 marks)

(d) Show that

$$\frac{F}{\rho V^2 L^2} = \text{fn}\left[\frac{gL}{V^2}, \frac{\mu}{\rho VL}\right]$$

when resistance force *(F)* for a boat has related with a function of length *L*, velocity *V*, acceleration gravity *g*, density flow ρ , and dynamic viscosity μ.

(9 marks)

– END OF QUESTIONS –

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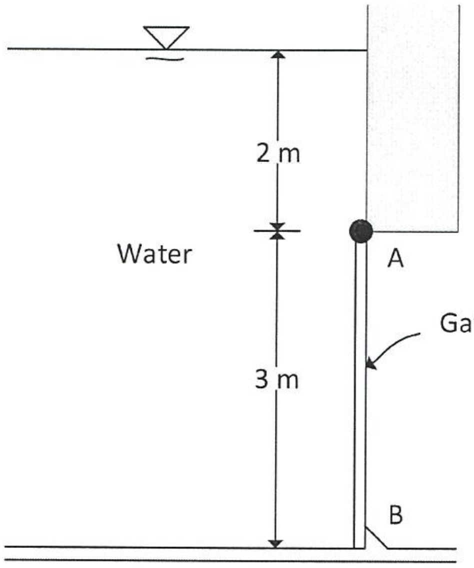

FIGURE Q1(d)

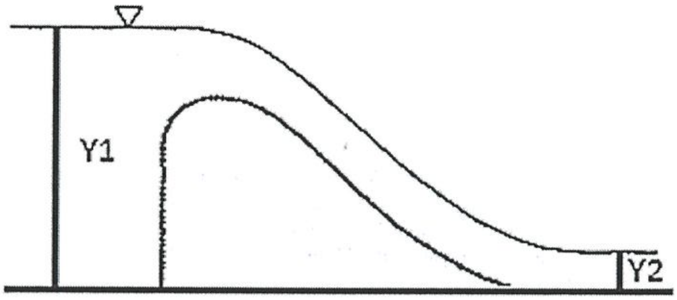

FIGURE Q2(d)

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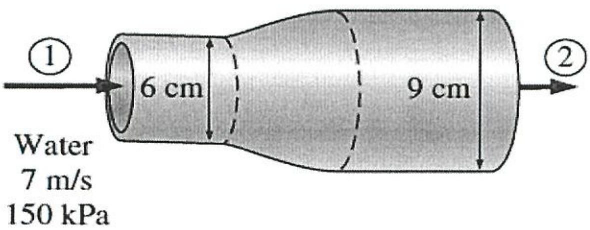

FIGURE Q3(c)

LIST OF FORMULA

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

$$I_{xx} = \frac{bh^3}{12} \qquad H = \frac{P}{\gamma} + z + \frac{V^2}{2g} \qquad F = \rho Q \Delta V \qquad h_f = \frac{fLV^2}{2gD}$$

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

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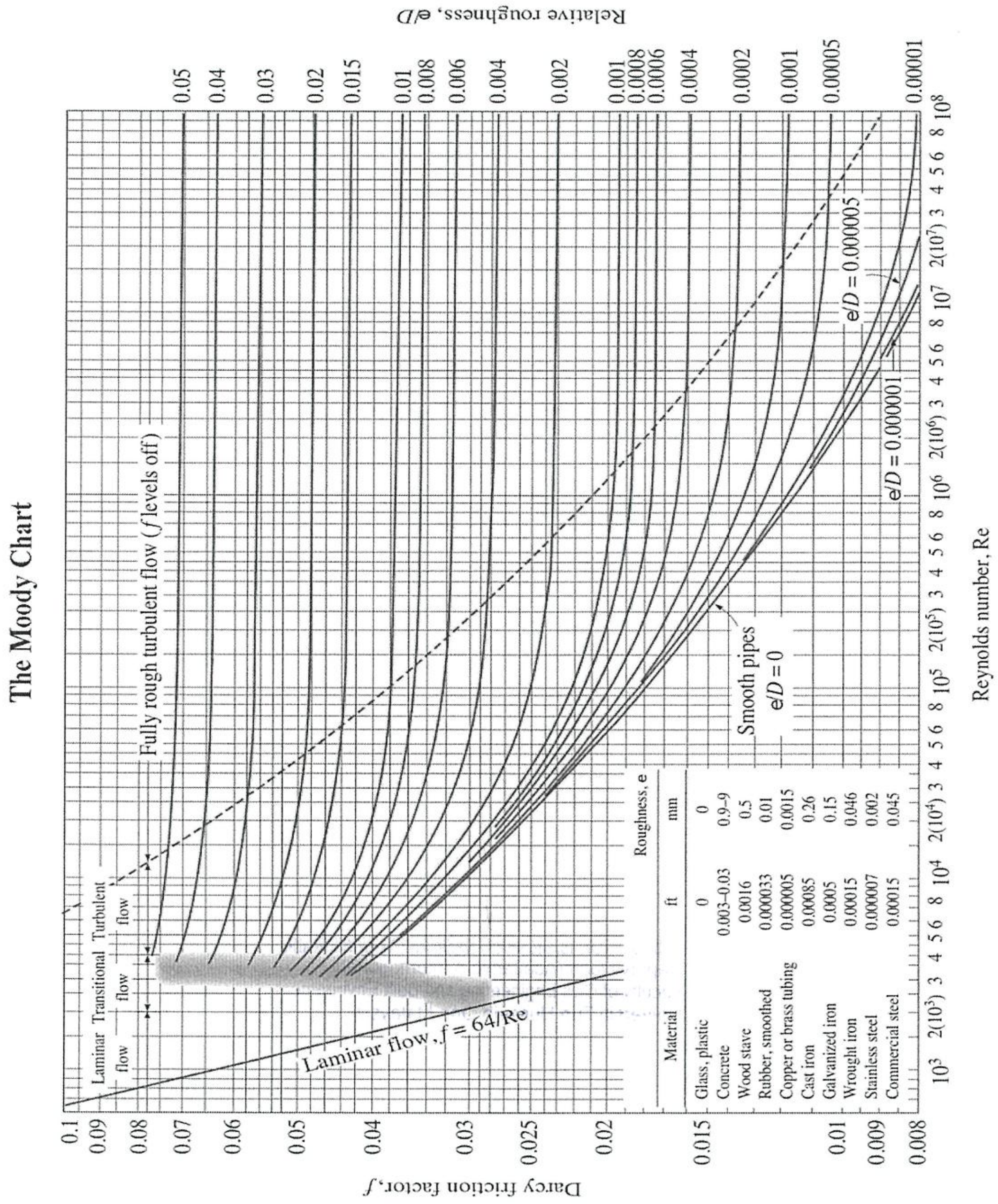

FIGURE Q3(d)

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TABLE Q4 : 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}
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}