Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	BNP 10303
PROGRAMME CODE	:	BNA/BNB/BNC
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ 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

Q1 The capillary effect in fluid mechanics and the use of a manometer are both concerned with measuring pressure, albeit in different contexts.

(a) Explain the capillary effect of water and mercury.

(6 marks)

(b) Figure Q1.1 shows a mercury manometer attached to a container of oil. Calculate the value of h if specific gravity (SG) for oil is 0.8.

(8 marks)

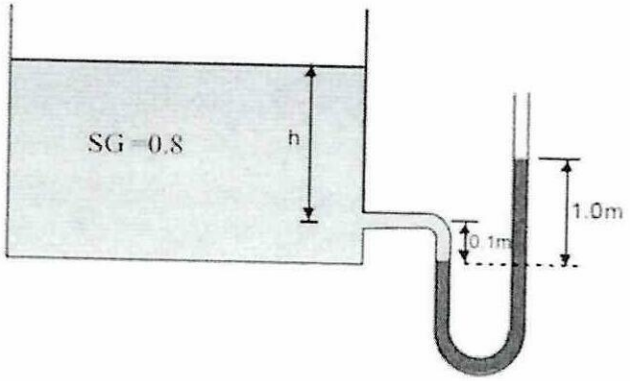


Figure Q1.1 A mercury manometer attached to a container.

(c) A semi-circular gate is shown in **Figure Q1.2**. Given the width of the gate is 1.2 m, the mass is 1000 kg. Analyse the force, F that is required to lift the gate.

(11 marks)

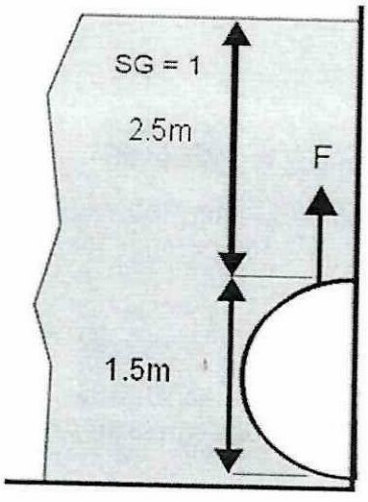


Figure Q1.2 A semi-circular gate.

Q2 The purpose of venturimeter is to gauge the flow rate of water jetting through the irrigation channels by optimizing the distribution efficiency.

(a) Given the velocity of a liquid is 1.2 m/s in a 160 mm pipeline with a specific gravity of 1.7, determine below:

(i) Flow rate in m^3/s

(2 marks)

(ii) Mass flow rate

(2 marks)

(iii) Weight flow rate

(2 marks)

(b) **Figure Q2.1** shows a venturi meter equipped with a manometer. The specific gravity of the gage fluid in the manometer is 1.20 ($\gamma g = 14.02$ kN/m^3) while the venturi meter flows water at 50°C (9.69 kN/m^3).

(i) Calculate the pressure difference between A and B.

(5 marks)

(ii) Justify that the velocity at B is four times higher than at A.

(3 marks)

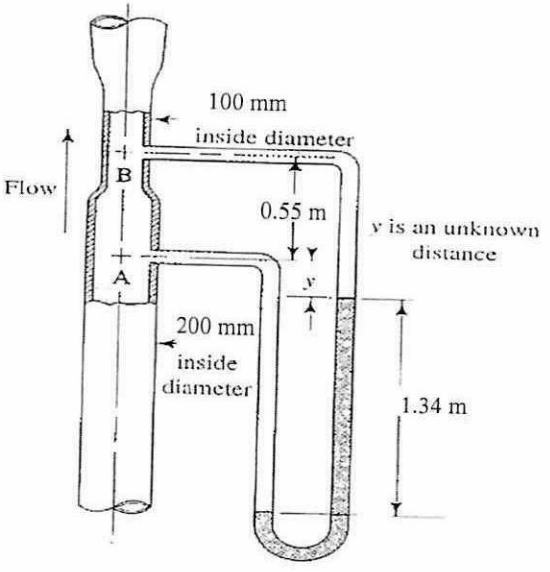


Figure Q2.1 Venturi meter equipped with a manometer

(c) **Figure Q2.2** shows a water jet strikes on a vane at 35°. The water flows at 0.82 kg/s with a velocity of 27 m/s.

(i) Estimate the resultant force and its direction.

(8 marks)

(ii) Construct a diagram showing the resultant force and its direction.

(3 marks)

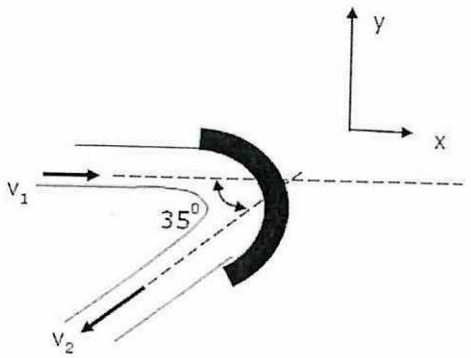


Figure Q2.2 A water jet strikes on a vane at 35°.

Q3 Understanding pressure and head loss in pipes is essential for designing and analysing piping systems in various engineering applications, including fluid transport systems.

(a) Sketch and explain **THREE (3)** differences in the characteristics of laminar and turbulent flow in the pipes.

(8 marks)

(b) A galvanized iron pipe with a diameter of 3.5 m is used to flow water in horizontal axis at rate of 65 m^3/s. If the difference of pressure heads is 2 m and kinematic viscosity, υ is given as 1.13×10^{-6} m^2/s, determine the length of pipe.

(6 marks)

(c) A 6 cm diameter horizontal water pipe expands gradually to a 9 cm diameter pipe as shown in **Figure Q3.1.** The walls of the expansion section are angled 10° from the axis. The average velocity and pressure of water before the expansion section are 7 m/s and 150 kPa, respectively. By referring to **Figure Appendix A2**, analyze below:

(i) The head loss in the expansion section.

(6 marks)

(ii) The pressure in the larger diameter pipe.

(5 marks)

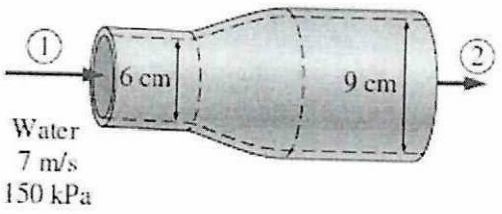


Figure Q3.1 Horizontal water pipe

Q4 Energy line (EL) is defined as the total head in the system while hydraulic grade line (HGL) is the piezometric head for a certain cross section in a system of a pipe. The correlation between pipe systems and similarity underscores the foundational principles governing fluid mechanics and engineering.

(a) Define **THREE (3)** forms of energy develop in a pipe system.

(4 marks)

(b) Draw a correlation graph of EL, HGL and energy development in a pipe system.

(4 marks)

(c) The drag force on a submarine, which is moving on the surface, is to be determined by a test on a model which is scaled down to one-twentieth of the prototype with the speed of 2.1 m/s. The test is to be carried in a towing tank, where the model submarine is moved along a channel of liquid. By using Froude number calculate the speed at which the model should be moved in the towing tank.

(6 marks)

(d) The flow into and out of a loop pipe system is shown in **Figure Q4.1** with the K values for each pipe were given and n = 2. Estimate the flow in each pipe and $\triangle Q$ from first trial by using Hardy Cross Method.

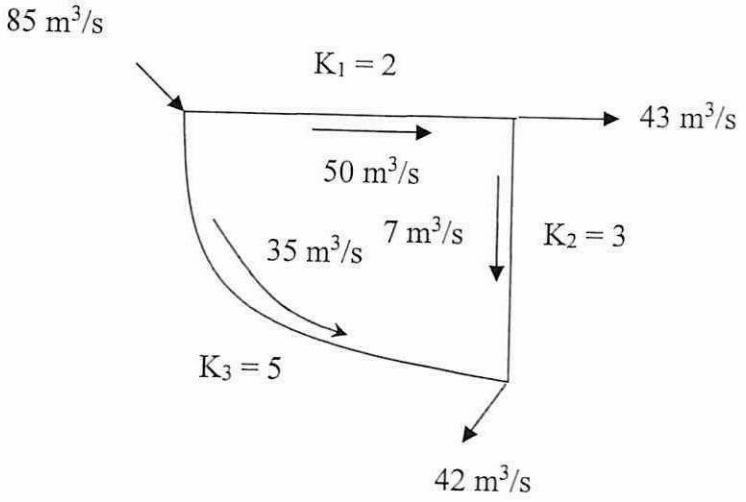
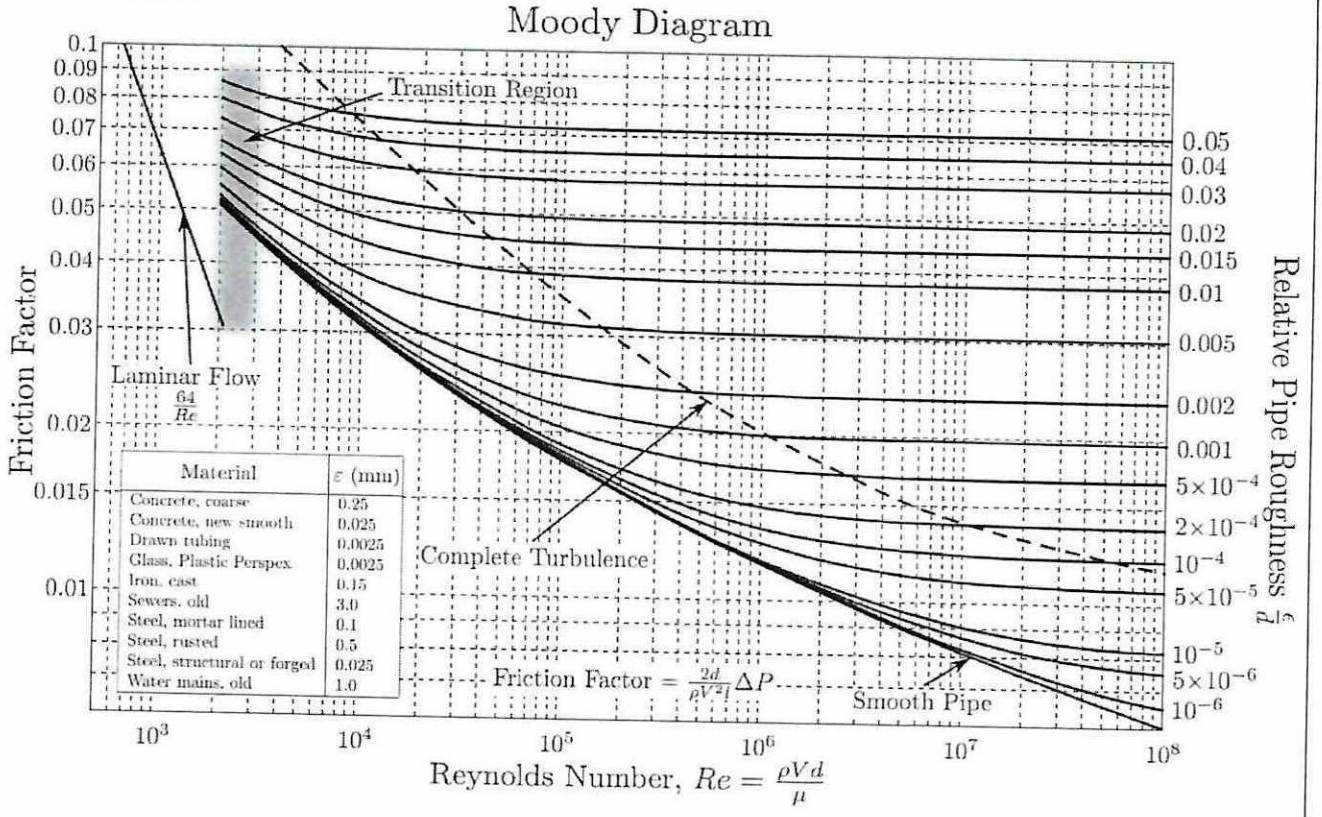


Figure Q4.1 A loop pipe system

(11 marks)

- END OF QUESTIONS -

APPENDIX A



Material	ε (mm)
Concrete, coarse	0.25
Concrete, new smooth	0.025
Drawn tubing	0.0025
Glass, Plastic Perspex	0.0025
Iron, cast	0.15
Sewers, old	3.0
Steel, mortar lined	0.1
Steel, rusted	0.5
Steel, structural or forged	0.025
Water mains, old	1.0

Figure APPENDIX A.1

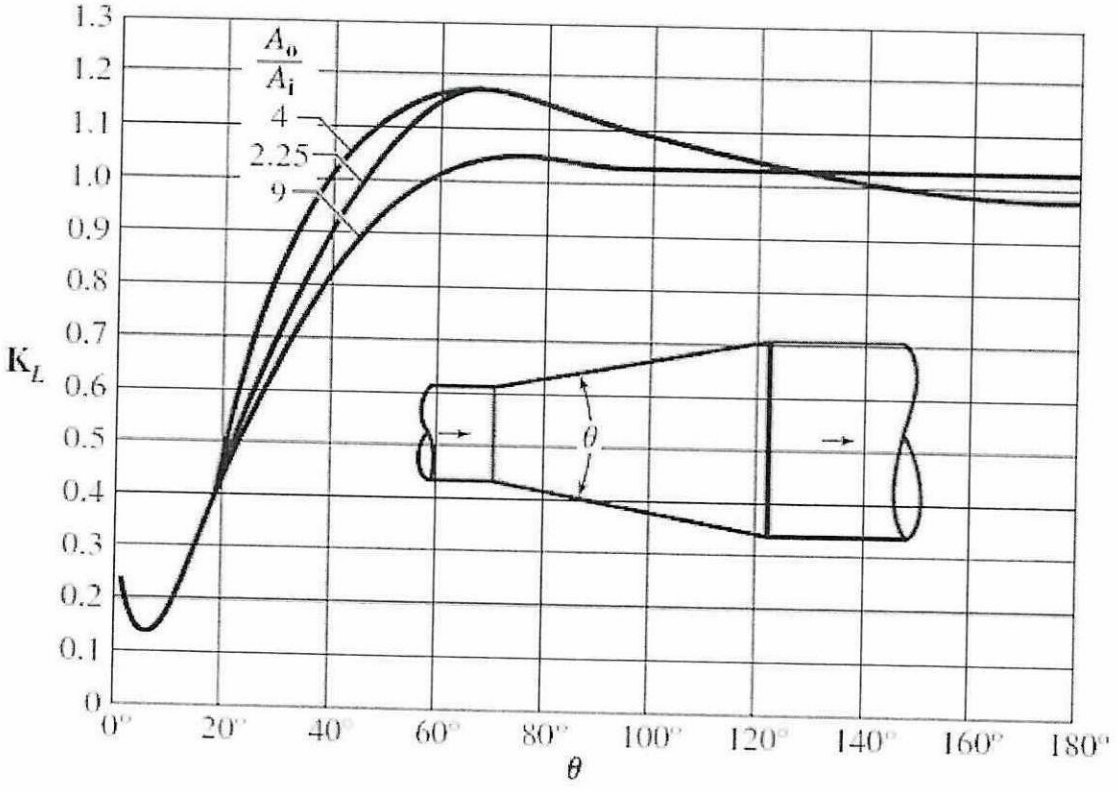


Figure APPENDIX A.2

APPENDIX B

Table APPENDIX B.1

Material	Roughness, ε ft	Roughness, ε mm
Glass, plastic	0 (smooth)	
Concrete	0.003–0.03	0.9–9
Wood stave	0.0016	0.5
Rubber, smoothed	0.000033	0.01
Copper or brass tubing	0.000005	0.0015
Cast iron	0.00085	0.26
Galvanized iron	0.0005	0.15
Wrought iron	0.00015	0.046
Stainless steel	0.000007	0.002
Commercial steel	0.00015	0.045

APPENDIX C

FORMULA

$Q = \frac{m}{\rho}$ $V = \frac{Q}{A}$ $R = \frac{VD}{\nu}$ $\varepsilon = \frac{e}{D}$ $h_f = \frac{fLV^2}{2gD}$

$h_L = KQ^n$ $n|KQ^{n-1}|$ $\Delta Q = -\sum h_L / \sum n h_L = -\sum KQ^n / \sum n[KQ^{n-1}]$

$F_r = \frac{V}{\sqrt{gL}}$ $Q = AV$ $a_{circle} = \frac{\pi D^2}{4}$ $F = m\ (v_2 - v_1)$

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

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

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

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

$V = \sqrt{2gh}$ $h_L = H - \frac{V_a}{2g}$ $F_r = \frac{V}{\sqrt{gL}}$ $\nu = \mu/\rho$ $\tau = \mu\ (du/dy)$

$Q = C_d a\sqrt{2gH}$ $\dot{m} = \rho A V$ $P = F/A$

$Q = AV$ $m = \rho Q$ $G = \gamma Q$ $A_A V_A = A_B V_B$ $F = m \times (V_2 - V_1)$

$$\frac{p_A}{\rho g} + z_A + \frac{V_A^2}{2g} = \frac{p_B}{\rho g} + z_B + \frac{V_B^2}{2g}$$