UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION (ONLINE) SEMESTER I SESSION 2020/2021

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	DAM 22003
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	JANUARY/FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY **OPEN BOOK EXAMINATION**

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THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1　(a)　An open ended U-tube manometer is attached to a container of gas that is exerting a pressure of 108.5 kPa. The atmospheric pressure is 99.8 kPa.

　　　(i)　Draw a diagram of the manometer.

　　　　　　　　　　　　　　　　　　　　　　(2 marks)

　　　(ii)　When the valve of the container is opened, will the mercury in the open arm of the u-tube move up or down? Why?

　　　　　　　　　　　　　　　　　　　　　　(2 marks)

　　　(iii)　After the mercury in the U-tube stops moving what will be the difference in height of the mercury levels in the two arms.

　　　　　　　　　　　　　　　　　　　　　　(6 marks)

　　(b)　Two tanks are connected through a mercury manometer with inclined tubes, as shown in **Figure Q1(b)**.

　　　(i)　From the figure which tank has the higher pressure, A or B. Give a reason for your answer.

　　　　　　　　　　　　　　　　　　　　　　(2 marks)

　　　(ii)　Find a and θ if the pressure difference between the two tanks is 20 kPa.

　　　　　　　　　　　　　　　　　　　　　　(8 marks)

Q2　A 3-m-long quarter-circular gate of radius 2 m is hinged about its upper edge at A as shown in **Figure Q2**. The spring is used to pressed the gate to control the water flow over the ledge B. Determine the minimum spring force required to keep the gate closed when the water level reaches 6.8 m.

　　　　　　　　　　　　　　　　　　　　　　(20 marks)

Q3　The flow rate of methanol at 20°C (density = 788.4 kg/m^3) through a 4-cm-diameter pipe is to be measured with a 3-cm-diameter orifice meter equipped with a mercury manometer across the orifice plate. If the contraction and velocity coefficient of the orifice meter are 0.63 and 0.97 respectively, and the differential height of the manometer is read to be 11 cm,

　　(i)　determine the flow rate of methanol through the pipe and the average flow velocity.

　　　　　　　　　　　　　　　　　　　　　　(16 marks)

　　(ii)　Sketch the schematic diagram of the system.

　　　　　　　　　　　　　　　　　　　　　　(4 marks)

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Q4 (a) Explain the principle used to derive the Continuity Equation with an appropriate example.

(4 marks)

(b) An orifice plate is install to the end of a 12 cm diameter pipe. The contractions in a cross sectional area of the pipe cause the water to exit the orifice at a 25 mm diameter of jet flow. If the mass flow rate and the pressure in the pipe is 20.4 kg/s and 800 kPa respectively, calculate the force required to hold the orifice plate in place.

(16 marks)

Q5 The system delivers water from a reservoir at point 1 to reservoir at point 2. This system consists of 1200 m length of cast-iron pipe with a diameter of 5 cm, two 45° elbows ($K_L = 0.2$ each), four 90° elbows ($K_L = 0.3$ each), a fully open globe valve ($K_l = 8.5$) and a sharp exit ($K_l = 1.0$) into a reservoir. The elevation at point 1 is 400 m and elevation at point 2 is 500 m.

(i) Sketch the schematic diagram of the system.

(4 marks)

(ii) Calculate gauge pressure at point 1 to deliver 0.005 m3/s of water at 20° C into the reservoir.

(16 marks)

Q6 (a) The pressure drop in a smooth horizontal pipe in a turbulent, incompressible flow depends on the pipe diameter, pipe length, fluid velocity, fluid density, and viscosity.

$$\Delta p = f(D, S, V, \rho, \mu)$$

Find a non-dimensional relationship for the pressure drop.

(15 marks)

(b) Oil with kinematic viscosity of 4.2×10^{-4} m²/s is pumped through a 914 mm diameter pipeline at a rate of 0.5 m³/s. A model of this pipeline is to be designed using a 76 mm diameter pipe and water at 20°C as the working fluid. Determine the fluid velocity required in the model to maintain Reynolds number similarity between these two systems.

(5 marks)
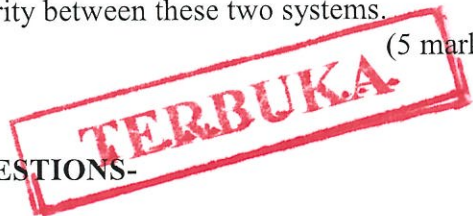
-END OF QUESTIONS-

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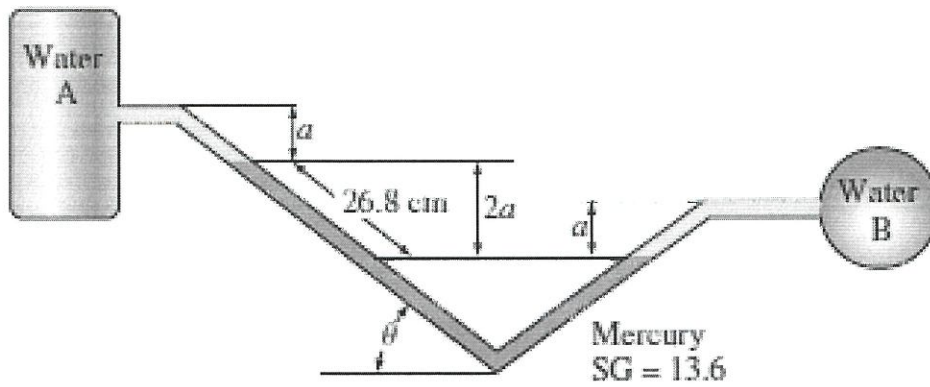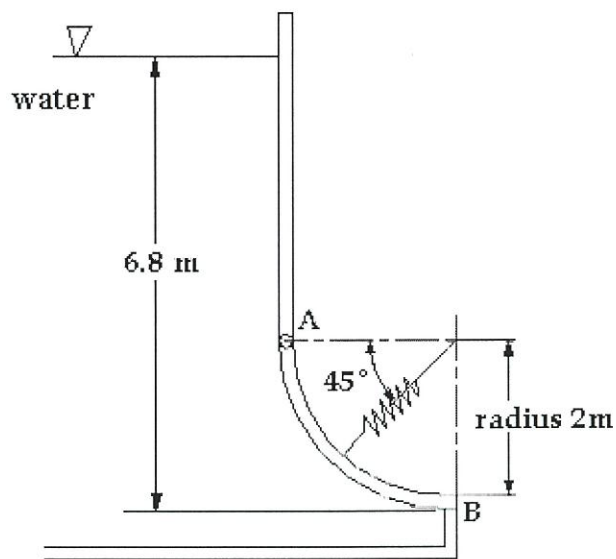
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Figure Q1(b)
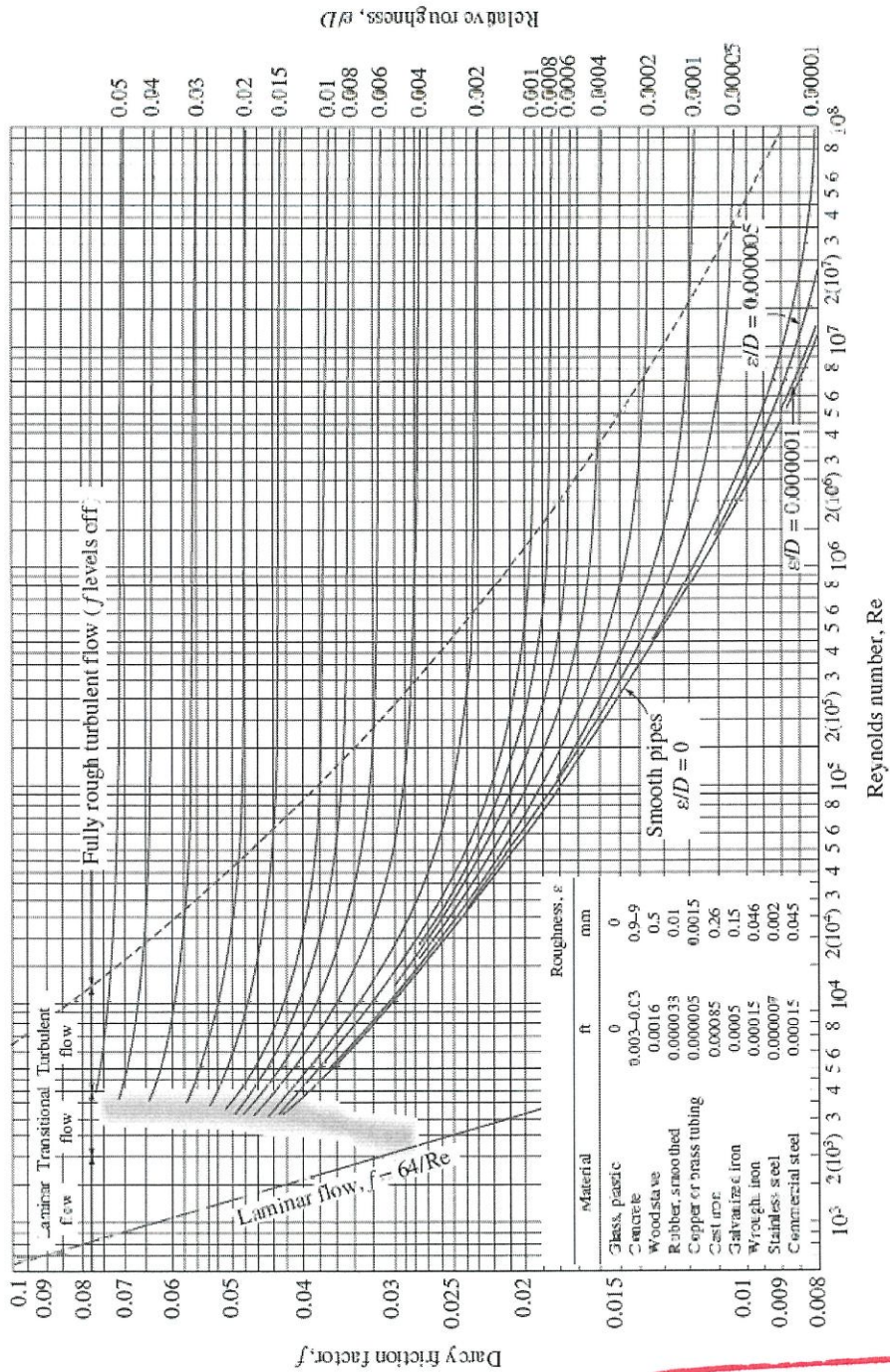
Figure Q2

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Figure 5 : Moody Chart

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TABLE 1 : PHYSICAL PROPERTIES OF WATER (SI UNITS)

Temperature ($°C$)	Density, ρ (kg/m^3)	Specific Weight[b], γ (kN/m^3)	Dynamic Viscosity, μ ($N·s/m^2$)	Kinematic Viscosity, ν (m^2/s)	Surface Tension[c], σ (N/m)	Vapor Pressure, p_v [N/m^2(abs)]	Speed of Sound[d], c (m/s)
0	999.9	9.806	$1.787\ E-3$	$1.787\ E-6$	$7.56\ E-2$	$6.105\ E+2$	1403
5	1000.0	9.807	$1.519\ E-3$	$1.519\ E-6$	$7.49\ E-2$	$8.722\ E+2$	1427
10	999.7	9.804	$1.307\ E-3$	$1.307\ E-6$	$7.42\ E-2$	$1.228\ E+3$	1447
20	998.2	9.789	$1.002\ E-3$	$1.004\ E-6$	$7.28\ E-2$	$2.338\ E+3$	1481
30	995.7	9.765	$7.975\ E-4$	$8.009\ E-7$	$7.12\ E-2$	$4.243\ E+3$	1507
40	992.2	9.731	$6.529\ E-4$	$6.580\ E-7$	$6.96\ E-2$	$7.376\ E+3$	1526
50	988.1	9.690	$5.468\ E-4$	$5.534\ E-7$	$6.79\ E-2$	$1.233\ E+4$	1541
60	983.2	9.642	$4.665\ E-4$	$4.745\ E-7$	$6.62\ E-2$	$1.992\ E+4$	1552
70	977.8	9.589	$4.042\ E-4$	$4.134\ E-7$	$6.44\ E-2$	$3.116\ E+4$	1555
80	971.8	9.530	$3.547\ E-4$	$3.650\ E-7$	$6.26\ E-2$	$4.734\ E+4$	1555
90	965.3	9.467	$3.147\ E-4$	$3.260\ E-7$	$6.08\ E-2$	$7.010\ E+4$	1550
100	958.4	9.399	$2.818\ E-4$	$2.940\ E-7$	$5.89\ E-2$	$1.013\ E+5$	1543

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