UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 2 Examination in Engineering: December 2018

Module Number: CE2201 **Module Name: Fundamentals of Fluid Mechanics**

[Three Hours]

[Answer all questions. Each question carries TWELVE marks]
All Standard Notations denote their regular meanings

Q1. a) A manometer is connected to a closed tank filled with three different types of fluids as shown in Figure Q1a. Determine the density of Fluid 3.

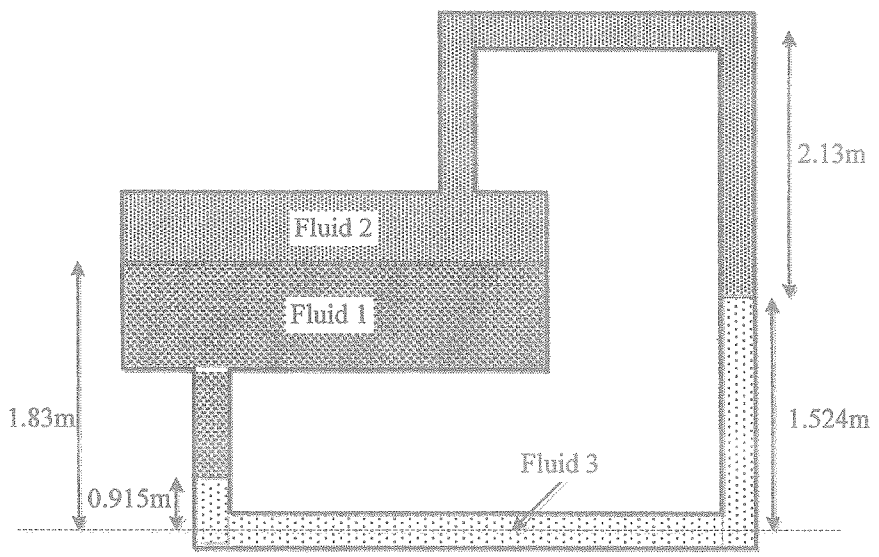


Figure Q1a

[4 Marks]

b) A manometer is connected to two pipes, Pipe A and Pipe B, as in Figure Q1b.

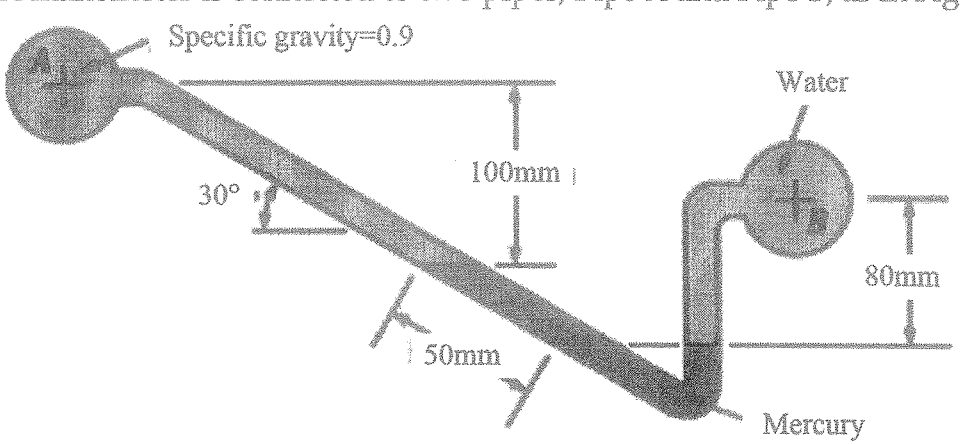


Figure Q1b

(i) Calculate the pressure difference in pipes.

[4 Marks]

(ii) Determine the new differential reading along inclined leg, if the pressure in pipe A is decreased by 10 kPa and pressure in pipe B remains unchanged.

[4 Marks]

Q2. a) Inner face of a dam takes the form of a parabola with the equation $12y = x^2$, where y is the height above the base and x is the horizontal distance of the face from the vertical reference plane. The water level is 12 m above the base. Determine the thrust on the dam per metre width due to the water pressure.

[6 Marks]

b) A cylindrical tank of diameter $3d$ contains water in which a solid circular cylinder of length l and diameter d floats with its axis vertical. Oil is poured into the tank so that the length of float finally protruding above the oil surface is $l/20$. Relative densities of the oil and the cylinder are 0.8 and 0.9, respectively. Determine vertical movement of the float and the draught in each liquid.

[6 Marks]

Q3. Two cylindrical tanks having diameters of $D_1 = 30$ cm and $D_2 = 20$ cm are connected as in Figure Q3 to determine the discharge coefficient of an orifice having a diameter of 5 mm. At the beginning, water heights in the tanks are $h_1 = 110$ cm and $h_2 = 15$ cm as in Figure Q3. If it takes 100 seconds to equalize the water levels in the tanks and to stop the flow, determine the discharge coefficient of the orifice disregarding other losses.

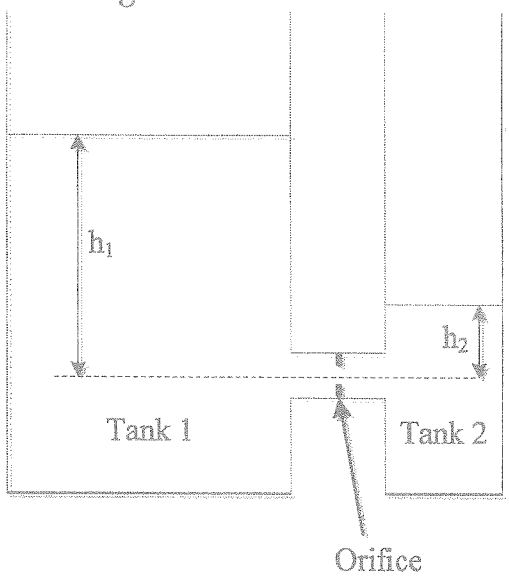


Figure Q3

[12 Marks]

Q4. A circular water pipe has an abrupt expansion from diameter $D_1 = 15$ cm to $D_2 = 20$ cm.

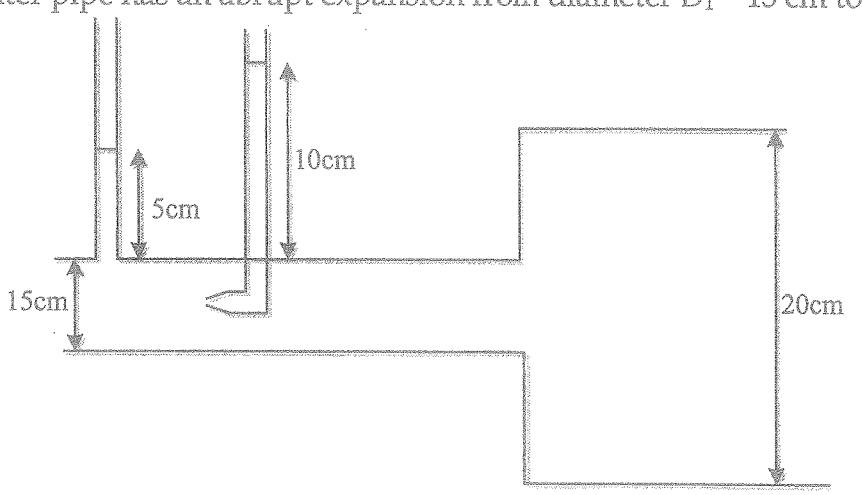


Figure Q4

a) Calculate the average water velocity and pressure in the smaller pipe.

[3 Marks]

b) By applying the continuity, momentum, and energy equations to the control volume, show that the loss coefficient for sudden expansion is $K_L = \left(1 - \frac{D_1^2}{D_2^2}\right)^2$. You may consider that the pressure in the annular face AB is P_1.

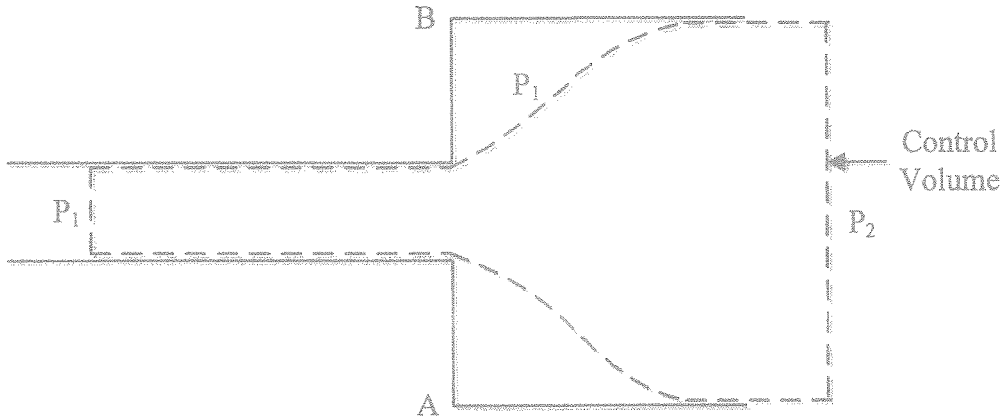


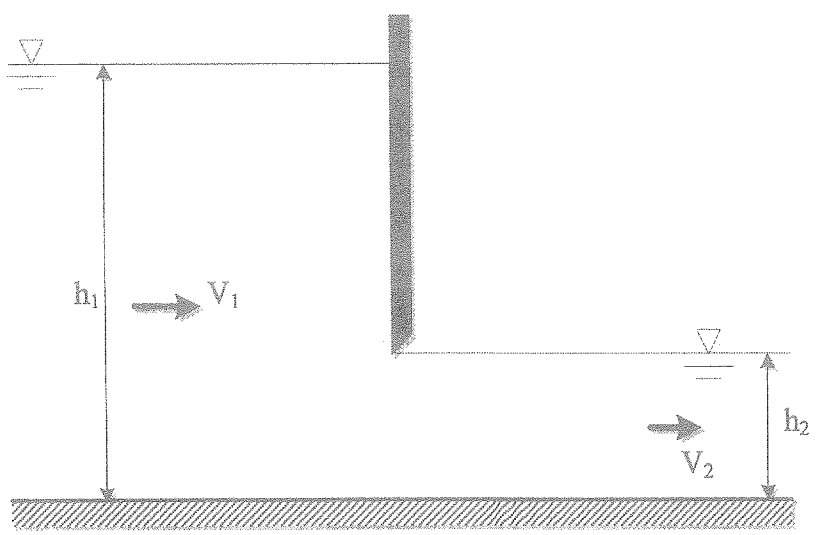
Figure Q4b

[7 Marks]

c) Calculate the loss coefficient, head loss, and the upstream pressure for the given case.

[2 Marks]

Q5. A sluice gate is installed in a steady incompressible open channel flow. Upstream water depth and velcoity are h_1 and V_1 while those at downstream are h_2 and V_2, respectively.



a) By applying continuity equation and Bernoulli's euqation, derive an expression for the downstream velocity V_2. Verify your results by showing that the expression reduced to Torricelli equation as h_2 approaches 0.

[6 Marks]

b) Draw the pressure variation with depth in upstream and downstream of the gate. By applying linear momentum equation, derive an expression for the horizontal force (F) required to hold the gate in place. Verify your expression by showing that F=0 when $h_1 = h_2$ and F is the result given by fluid statics when $h_2 = 0$.

[6 Marks]