UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 2 Examination in Engineering: November 2017

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. Figure Q1 shows a gate of negligible weight hinged at **A**, supporting water in one side.

(i) If water height (h) is 2 m, calculate the resultant pressure force on the gate and find the centre of pressure. Consider unit width of the gate.

[8.0 Marks]

(ii) Find the maximum height of water, h that the gate can support. Consider unit width of the gate.

[4.0 Marks]

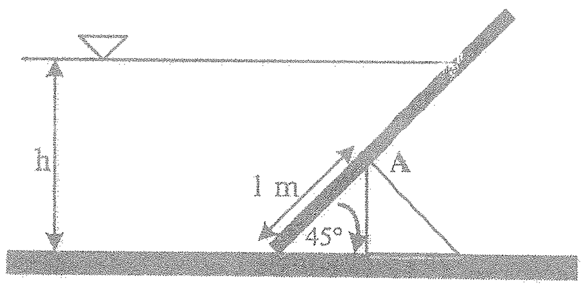


Figure Q1

Q2. A cylinder 1.2 m in diameter and 2 m ~~high~~ height has a mass of 800 kg. The center of gravity of the cylinder is 1 m from its base.

a) Show that it will not float with its axis vertical in water.

[6.0 Marks]

b) Calculate the least vertical downward force applied at the base that would just keep the cylinder vertical.

[6.0 Marks]

Q3. A liquid of constant density ρ flows steadily in a horizontal square section duct of side $h = 0.3\ m$ with a velocity variation across the duct section as shown in Figure Q3.

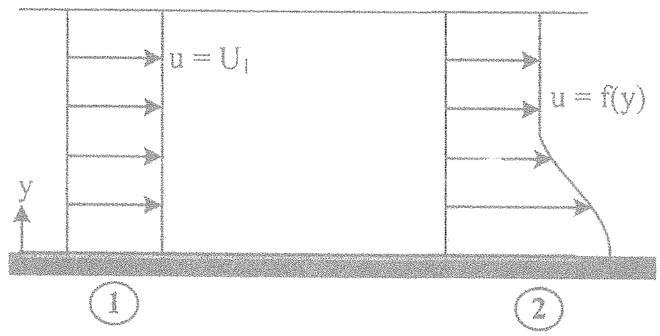


Figure Q3

At section 1: $u = U_1$

At section 2: $u = \begin{cases} 2 & for\ \ h/2 \le y \le h \\ 3 + Cos\left(\frac{2\pi y}{h}\right) & for\ \ 0 \le y \le h/2 \end{cases}$

(i) Calculate the upstream velocity U_1.

[6.0 Marks]

(ii) If the pressure difference between section (1) and (2) is 20 kPa, find the force in the section between (1) and (2) .

[6.0 Marks]

Q4. A pipe bend in a vertical plane turns the water flow direction through a 120° before discharging to the atmosphere. The inlet pipe diameter is 300 mm and at outlet it is 150 mm. The inlet pipe is horizontal and the centre of the outlet section is 1.4 m below the inlet pipe. The head loss in the pipe bend is $10\frac{V_1^2}{2g}$, where V_1 is the velocity of water at the inlet. The total volume of fluid contained in the bend is 0.085 m³. Calculate the magnitude and direction of the net force exerted on the bend when the inlet pressure is 140 kPa.

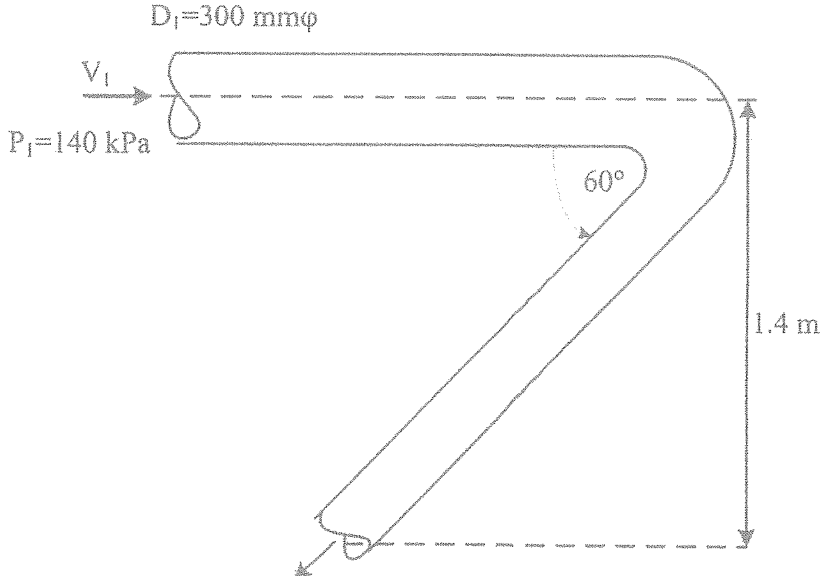


Figure Q4

[12.0 Marks]

Q5. a) Water is delivered to reservoir **B** from reservoir **A** through a 200 mm diameter pipeline having a length of 1000 m and a friction coefficient of 0.01. Frictional head loss through a pipeline is given by $h_f = \lambda \frac{L}{D}\frac{V^2}{2g}$ with usual notation. Calculate the flow through the pipe line if the water level at reservoir **B** is 15 m below that of reservoir **A**.

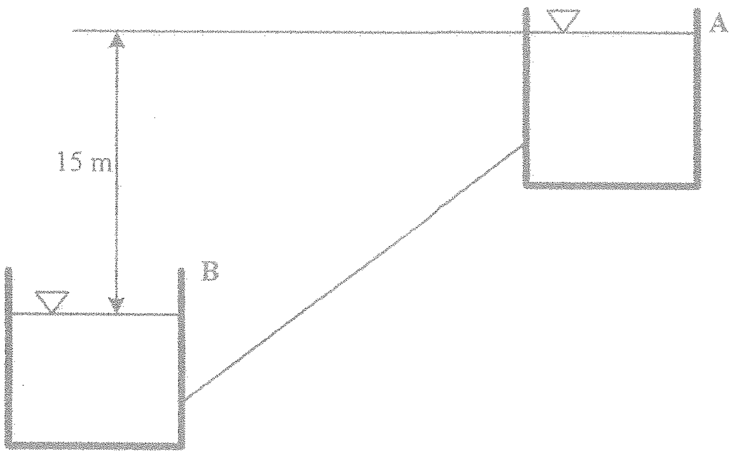


Figure Q5

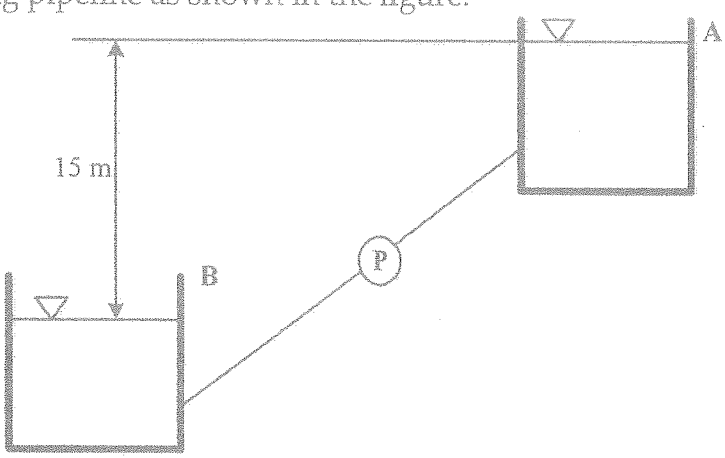
[3.0 Marks]

b) To increase the flow three possible options are considered.

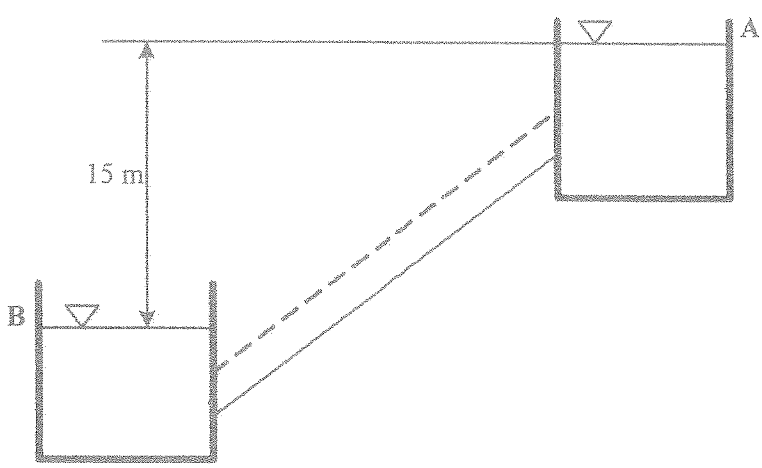
Option A: Installing a pump

Option B: Laying a new pipe line parallel to existing pipeline

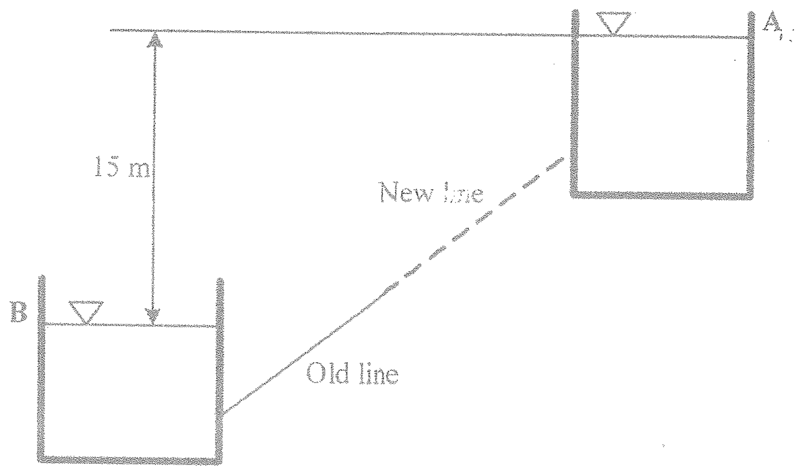
Option C: Connecting a 250 mm diameter pipeline having a length of L to the existing pipeline as shown in the figure.



Option A



Option B



Option C

If it is required to supply a total of 0.150 m^3/s of water, calculate the

(i) Head required by the pump in option A
(ii) Diameter of the new pipeline for option B
(iii) Length of the new pipeline for option C

Consider that friction coefficient is 0.01 for all pipes.

[3.0 Marks for each]