

1) Given Sp of gravity  $\rho = \rho$ ,  $Q = 150 \text{ mm} = 0.15 \text{ m}$ ,  $D_1 = 75 \text{ mm}$   
 $= 0.075 \text{ m}$   $Z_2 - Z_1 = 150 \text{ mm} = 0.15 \text{ m}$ ,  $Q = 4 \text{ m}^3/\text{sec}$   
 $= 0.04 \text{ m}^3/\text{s}$ ,  $C_d = 0.96$  pressure difference  $(P_1 - P_2)$

$$A_1 = \frac{\pi D_1^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.01767 \text{ m}^2$$

$$A_2 = \frac{\pi D_2^2}{4} = \frac{\pi \times 0.075^2}{4} = 0.00442 \text{ m}^2$$

$$Q = C_d \times A_1 A_2 \times \sqrt{2gh}$$

$$0.04 = \frac{0.96 \times 0.01767 \times 0.00442 \times \sqrt{2 \times 9.81 \times h}}{\sqrt{h^2 - A_1^2}}$$

$$0.04 = 0.96 \times 0.004565 \times \sqrt{h}$$

$$h = \left( \frac{0.04}{(0.96 \times 0.004565 \times 4.429)} \right)^2 = 4.247 \text{ m}$$

$$h = \left( \frac{P_1}{\rho} + Z_1 \right) - \left( \frac{P_2}{\rho} + Z_2 \right)$$

$$h = \left( \frac{P_1 - P_2}{\rho} \right) + (Z_1 - Z_2)$$

$$4.247 = \left( \frac{P_1 - P_2}{\rho} \right) - 0.15$$

$$4.247 + 0.15 = \left( \frac{P_1 - P_2}{\rho} \right) \Rightarrow 4.397 + 0.15 = \left( \frac{P_1 - P_2}{\rho} \right)$$

$$(4.397 + 0.15) \rho = P_1 - P_2$$

$$P_1 - P_2 = (0.8 \times 1000 \times 9.81) (4.397 + 0.15)$$

$$P_1 - P_2 = 34514 \text{ N/m}^2$$

$$\frac{P_1 - P_2}{\omega} = 3.53 + 0.3$$

$$\frac{P_1 - P_2}{\omega} = 3.83$$

$$P_1 - P_2 = 3.83 \omega$$

$$P_1 - P_2 = 3.83 \times 9.81 \times 0.9$$

$$P_1 - P_2 = 33.8 \text{ kN/M}^2 \rightarrow$$

2. Diameter of inlet  $D_1 = 300 \text{ mm} = 0.3 \text{ m}$

Area of inlet  $A_1 = \pi D_1^2 / 4 = \pi \times 0.3^2 / 4 = 0.07 \text{ m}^2$

Diameter of throat  $D_2 = 150 \text{ mm} = 0.15 \text{ m}$

Area of inlet  $A_2 = \pi D_2^2 / 4 = \pi \times 0.15^2 / 4 = 0.0176 \text{ m}^2$

Sg of heavy liquid (mercury) in U-tube manometer

$S_H = 13.6$

Sg of oil flowing through pipe  $S_o = 0.9$

Reading of differential manometer  $y = 250 \text{ mm} = 0.25 \text{ m}$

The differential 'h' is given by

$$h \left( \frac{\rho_1}{\rho} + z_1 \right) = \left( \frac{\rho_2}{\rho} + z_2 \right)$$

$$= y \left[ \frac{S_H}{S_o} - 1 \right] = 0.25 \left[ \frac{13.6}{0.9} - 1 \right] = 3.53 \text{ m of oil}$$

a) Discharge of oil  $Q$

Using the relation

$$Q = C_d \times A_1 \times A_2 \times \sqrt{\frac{2gh}{A_1^2 - A_2^2}}$$

$$Q = 0.98 \times 0.07 \times 0.01767 \times \sqrt{\frac{2 \times 9.81 \times 3.53}{(0.07^2 - 0.01767^2) \text{ m}^2}}$$

$$Q = 0.14 \times 9 \text{ m}^3 \text{ s}^{-1}$$

b) Pressure difference between entrance and throat section

$P_1 - P_2$  . v/c known

$$h = \left( \frac{P_1}{\rho} - \frac{P_2}{\rho} \right) - (z_1 - z_2) = 3.53$$

$$z_2 - z_1 = 300 \text{ mm} = 0.3 \text{ m}$$

$$\left( \frac{P_1 - P_2}{\rho} \right) - 0.3 = 3.53$$