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Paper fluid Mechanics

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final term Exam

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Q 1

Ans Part A

Total Energy head :-

It is sum of all energy Potential head, velocity head and Pressure head at a Point in fluid

$$H = Z + \frac{V^2}{2g} + \frac{P}{w}$$

Various form of Energy

There are various form of total energy head which are

1) Kinetic Head
2) Potential head
3) Pressure head

1) Kinetic head:-

Kinetic head is Kinetic energy Per unit weight of fluid is known Kinetic head

$$K.H = V^2/2g$$

Potential Head :-

It is the Potential energy per unit weight of the fluid

$$\frac{P.E}{W} = \frac{mgh}{mg} = h$$

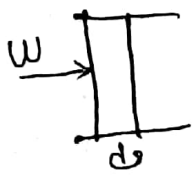
Pressure head :-

The vertical height of free surface above any point in a liquid at rest is Pressure head OR Level of fluid due to Pressure exerted by fluid

$$\text{Pressure head} = \frac{PE}{\text{weight}} = \frac{P}{\gamma}$$

OR

$$= \frac{f.ds}{W}$$



$$= \frac{P.A.ds}{W}$$

$= \frac{P.V}{W} \cdot \frac{P}{\gamma}$ is Pressure

Ans 1
Part B

Hydraulic Grade line:-

hydraulic grade line is the surface or Profile of water flowing in an open channel or a Pipe flowing Partially full. If a Pipe is under Pressure. the hydrulic grade line is that level water would rise to in a small verticall tube connected to the Pipe

Energy Line :-

It is defined as the Line which give the sum of Pressure head, datum head and Kinetic head of flowing fluid w.r.t some refrence line

OR

The Line which is obtain by connecting the tops of all vertical ordinates showing the sum of Pressure head & Kinetic head

hydraulic radius:-

The hydraulic radius (R_h) is the cross sectional area of flow divided by the wetted perimeter for a circular pipe flowing full. the hydraulic radius is one fourth of diameter for a wide rectangular channel. The hydraulic radius is approximatley equal to depth

$$Rh = A/P$$

A = Cross sectional area

P = wetted Parameter

Q2

Ans

Part (A)

Given data

30.58 + 0.101

$V = 2 m/sec$

$P = 300 kpa = 300 \times 10^3 N/m^2$

$Z = 5m$

H = Pressure head + K.E + P.E

~~$H = \frac{P}{w} + x^2$~~

$$H = Z + \frac{V^2}{2g} + P/w \longrightarrow (x)$$

$$H = \frac{5 + (2)^2}{2(9.81} + \frac{300}{9.81}$$

$$H = 35.785 \ Nm/N$$

Q2
Part B
Ans

Given data

$d_1 = 300mm$

$d_2 = 200mm$

P_1 = Pressure $= 300kPa = 300 \times 10^3 \ N/m^2$

$P_2 = 120 \ Kpa = 120 \times 10^3 \ N/m^2$

Datum $= Z = ?$

$Q = 40/100 \ m^2/sec$

$d_1 = 300mm = 0.3m$

$d_2 = 200mm = 0.2m$

Required

$Z_2 = ?$

Sol

$$A_1 = \frac{\pi d_1^2}{4}$$

$$A_1 = \frac{3.14 \times (0.3)^2}{4}$$

$$A_1 = 0.0706 m^2$$

$$A_2 = \frac{\pi d_2^2}{4}$$

$$A_2 = \frac{3.14 \times (0.2)^2}{4}$$

$$A_2 = 0.0314\ m^2$$

We know that

$$Q_1 = v_1 A_1$$

$$V_1 = Q / A_1$$

$$V_1 = \frac{0.04}{0.0706} \qquad \left\{ a = 40/1000 = 0.04 \right\}$$

$$V_1 = 0.566$$

$$V_2 = Q / A_2$$

$$V_2 = \frac{0.04}{0.0314} = V_2 = 1.27$$

Now

$$P_1/\gamma + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{V} + \frac{V_2^2}{2g} + Z_2$$

$$Z_1 = 0 \quad , \quad V = 9810$$

$$\frac{300 \times 10^3}{9810} + \frac{0.566^2}{2(9810)} + 0$$

$$= \frac{120 \times 10^3}{9810} + \frac{127}{2(981)} + Z_2$$

$$30.59 = 12.314 + Z_2$$

$$\boxed{Z_2 = 18.276}$$

Q3 Ans

Given data

$L = 500m$

$D = 0.2m$

$S = 0.9$

$\mu = 6 \times 10^{-5} \frac{N \cdot s}{m^2}$

$Q = 0.06\ m^3/sec$

$f = [0.0032 + (0.221/R\ 0.237)$

Sol Required: Pressure loss = DP = ?

we know that

$$f = \left[0.0032 + \left(\frac{0.221}{R\ 0.287}\right)\right.$$

where R is Reynold's numbers and is give as

$$R = \frac{V \times d}{V} \quad -①$$

and $V = \mu/g = \frac{6 \times 10^{-5}}{900}$

$V = 6.67 \times 10^{-8}\ m^2/s$

and $V = Q/A$

for circular Pipe

$A = \pi/d\, d^2$

$= \pi/4 (0.2)^2 = A = 0.031$

$V = \frac{0.06}{0.031}$

$V = 1.95$ m/s

Now eq ①

$$R = \frac{1.95 \times 0.2}{6.67 \times 10^{-5}} = 5.73 \times 10^6$$

Now $$f = \frac{0.0032 + 0.221}{(5.73 \times 10^6)^{0.237}}$$

$$f = 8.79 \times 10^{-3}$$

or

$$f = 0.00879$$

Now for bernoulis equation

$$\text{Head loss} = h_L = \frac{f l v^2}{2gD} \quad \text{— (ii)}$$

Putting value in eq (i)

$$h_L = \frac{(0.00879)(500)(1.95)^2}{2(9.81)(0.2)}$$

$$h_L = 4.259\ m$$

Now to find Pressure due to friction Pressure head formula is used

$$h_L = \frac{\Delta P}{\delta g}$$

$$\Delta P = h_L \times \delta g$$

Put value

$$\Delta P = 4.259 \times 900 \times 9.81$$

$$\Delta P = 37602.7 \text{ Pa}$$

$$\Delta P = 37.602 \text{ KPa}$$