Final term Paper

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Question # 01

a) Define total energy head and various forms of energy head with mathematical equations.

Total Energy head:-

It is the sum of all energy heads at a point in a fluid.

Forms of Energy Head:-

There are various forms of Energy head which are as follows.

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

Kinetic Head:-

It is the Kinetic energy per unit weight of the fluid.

Mathematical Form:-

$$\frac{K.E}{W} = \frac{1/2\, mv^2}{mg}$$

$$\frac{K.E}{W} = \frac{1}{2}\frac{V^2}{g}$$

This is also known as

Velocity Head.

Unit:-

Its unit is meter (m).

Potential Head:-

It is the potential energy per unit weight of the fluid.

Mathematical Form:-

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

Pressure Head:-

The vertical height of the free surface above any point in a liquid at rest is Pressure Head.

OR

level of fluid due to Pressure exerted by fluid.

Mathematical Form:-

$$\text{Pressure Head} = \frac{P.E}{\text{weight}} = \frac{P}{\gamma}$$

or

$$= \frac{F \cdot ds}{W}$$

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

$$= \frac{P \cdot V}{W} = \frac{P}{\gamma}$$

is Pressure.

Question #1

(b)

Define Hydraulic grade line, Energy line, Hydraulic radius.

Hydraulic grade line:-

It is the line showing the Pressure Head and the Potential Head at a point in fluid.

OR

The Surface or Profile of water flowing in an open Channel or pipe flowing Partially full. If a pipe is under Pressure. The Hydraulic grade line is that level water would rise to in a small vertical tube connected to the pipe.

Energy Line:-

It is the line joining the total heads along a pipe line.

OR.

A line that represents the elevation of enery head of water flowing ina pipe or channel.

The line is drawn above the Hydraulic grade line a distance equal to the velocity head ($v^2/2g$) of the water flowing at each section or channel.

Hydraulic Radius:-

The ratio of cross-sectional area of a channel or pipe in which a fluid is Flowing to the wetted permeter of the conduct.

Question #2

(a)

Calculate the total energy per unit weight .... the datum is 5m ?

Sol:-

$\gamma = 9810$

$V = 2\ m/sec$

$P = 300\ Kpa$

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

$Z = 5m$

$H = ?$

Now,

$H = $ pressure Head + K.E + P.E

$$H = \frac{P}{\gamma} + \frac{v^2}{2g} + Z$$

$$H = \frac{300 \times 10^3}{9810} + \frac{2^2}{2 \times 9.81} + 5$$

$$H = 30.58 + 0.20 + 5$$

$$\boxed{H = 35.78 \ Nm/N \text{ or } J/N}$$

Question #2

(b)

A tapering pipe is having diameter 300mm. ....
Assume that head loss is negligible?

Sol:-

Diameter, $d_1 = 300mm = 0.3m$

Diameter, $d_2 = 200mm = 0.2m$

pressure $= P_1 = 300$ Kpa

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

pressure $= P_2 = 120$ Kpa

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

Flow rate, $Q = \frac{40}{1000} m^2/s$

$= 0.04 \, m^2/s$

Datum $= z = ?$

As we know that

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

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

$$A_1 = 0.07065 \, m^2$$

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

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

$$A_2 = 0.0314 \ m^2$$

Now,

$$Q = V_1 A_1$$

$$V_1 = \frac{Q}{A_1}$$

$$V_1 = \frac{0.04}{0.07065}$$

$$V_1 = 0.5661 \ m/s$$

And,

$$V_2 = \frac{Q}{A_2}$$

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

$$V_2 = 1.2738 \text{ m/s}$$

Now,

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

where $Z_1 = 0$

$\gamma = 9810$

putting values,

$$\frac{300 \times 10^3}{9810} + \frac{(0.566)^2}{2 \times 9.81} + 0 = \frac{120 \times 10^3}{9810}$$

$$+ \frac{(1.27)^2}{2 \times 9.81} + Z_2$$

$$30.597 = 12.314 + Z_2$$

$$Z_2 = 30.597 - 12.314$$

$$\boxed{Z_2 = 18.285 \text{ m}}$$

Question # 03

A 500m long 0.2m diameter pipe transport an oil of specific gravity .... Reynold's number?

Sol:-

Length of the pipe, $L = 500m$

Diameter, $d = 0.2m$

specific Gravity of oil $= 0.9$

flow rate, $Q = 0.06\ m^3/s$

viscosity, $\mu = 6 \times 10^{-5}\ Ns/m^2$

Density, $\rho = 0.9 \times 1000$

$\rho = 900\ Kg/m^3$.

pressure loss, $\Delta P = ?$

As we know that,

$$\nu = \frac{\mu}{\rho}$$

$$\nu = \frac{6 \times 10^{-5}}{900}$$

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

Now,

we have to find "V"

$$V = \frac{Q}{A} \rightarrow (1)$$

Now for Circular pipe,

$$A = \frac{\pi d^2}{4}$$

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

$$A = 0.0314 m^2$$

putting Values in ① eq

$$V = \frac{Q}{A}$$

$$V = \frac{0.06}{0.0314}$$

$$V = 1.91 \ m/s$$

Now, we know that

$$R = \frac{V \times d}{\nu}$$

So,

$$R = \frac{1.91 \times 0.2}{6.67 \times 10^{-8}}$$

$$R = 5.72 \times 10^{6}$$

Now,

$$F = 0.0032 + \frac{0.221}{(5.72\times10^{6})^{0.237}}$$

$$F = 8.73209\times10^{-3}$$

Now,

From Bernouli's Equation,

$$H_L = \frac{FLv^2}{2gD}$$

$$H_L = \frac{(8.73209\times10^{-3})(500)(1.91)^2}{2\times(9.81)(0.2)}$$

$$H_L = 4.0590$$

Now,

We Know by pressure Loss and head loss relative,

(17)

$$H_L = \frac{\Delta P}{\rho g}$$

$$\Delta P = H_L \times \rho g$$

$$\Delta P = 4.0590 \times 900 \times 9.81$$

$$\Delta P = 35836.911 \ pa$$

$$\Delta P = 35837 \ pa$$

$$\boxed{\Delta P = 35.837 \ Kpa}$$