

FMHM.

3rd Sem Mech, CL

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PROBABLE SHORT QUESTIONS

MODULE - 01

① Q. Differentiate between Newtonian and Non-Newtonian fluid. 2011

A. Newtonian fluid :- A real fluid in which the shear stress is directly proportional to the rate of shear strain is known as Newtonian fluid.

Non-Newtonian fluid :- A real fluid in which the shear stress is not proportional to the rate of shear strain is known as non-Newtonian fluid.

② Q. A plate of 0.0254 mm distant from a fixed plate moves at 61 cm/sec and requires a force of $0.2 \text{ kgf}/\text{m}^2$ to maintain this speed.

Determine the dynamic viscosity of the fluid between the plates. 2011

Ans.

$$\text{Given: } dy = 0.0254 \text{ mm}$$

$$= 0.025 \times 10^{-3} \text{ m}$$

Velocity of upper plate,

$$U = 61 \text{ cm/s} = 0.61 \text{ m/s}$$

Force on upper plate,

$$F = 0.2 \text{ kgf}/\text{m}^2 = 2 \text{ N/m}^2$$

$$\frac{\downarrow}{dy} \frac{\text{upper plate}}{\text{lower plate}} \frac{U}{F}$$

$$\frac{\downarrow}{\uparrow} \frac{U}{F}$$

\therefore Shear stress, $\tau = \mu \frac{du}{dy}$

$$du = u - 0 = 0.6 \text{ m/s}$$

$$\tau = f = 2 \text{ N/m}^2$$

$$\therefore \mu = \frac{2 \times 0.254 \times 10^{-3}}{0.61} = 8.34 \times 10^{-5} \frac{\text{Ns}}{\text{m}^2}$$

$$= 8.34 \times 10^{-4} \text{ poise} : (\text{Ans})$$

③ a. What is metacentric height of a body? Why is it an important consideration for a body? 2011

M. Meta centre :- It is defined as the point about which a body starts oscillating when the body is tilted by a small angle.

Metacentric height :- The distance between the metacentre of a floating body and the centre of gravity of the stability of a floating body is determined from the position of meta-centre (M).

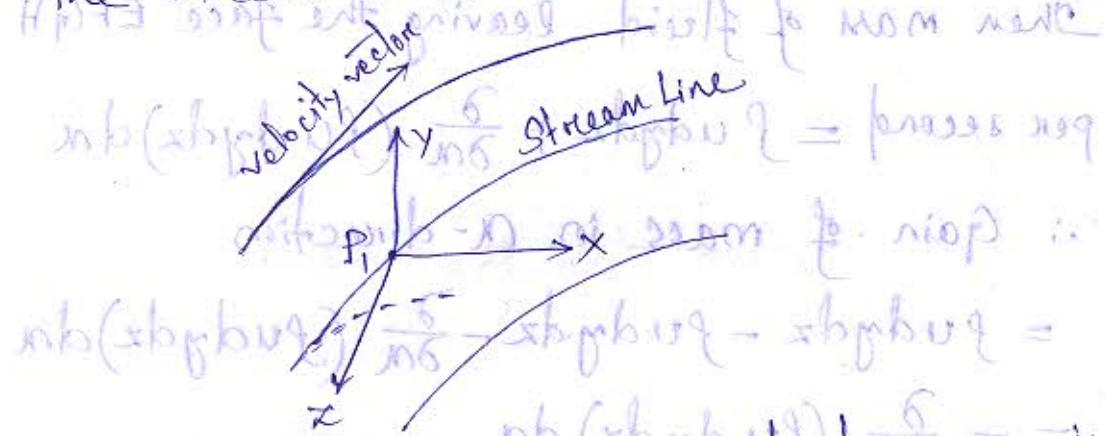
a) Stable Equilibrium :- If the metacentre M is above the centre of gravity G, the floating body will be in stable equilibrium.

b) Unstable Equilibrium :- If the metacentre M is below centre of gravity G, the floating body will be in unstable equilibrium.

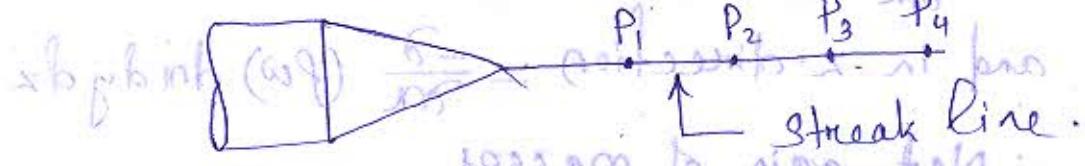
c) ~~d)~~ Neutral Equilibrium :- If the point M is at the centre of gravity of the body, the floating body will be in neutral equilibrium.

④ Q. Distinguish between stream line and streak line. 2011, 2010

A streamline is an imaginary line drawn through the flow field in a manner such that the velocity vector of the fluid at each and every point on the streamline is tangent to the streamline at that instant.



A streak line is the instantaneous picture of the position of all the fluid particles that have passed through a fixed point in the flow field.



⑤ Q. Write the expression for equation of continuity in differential form. 2011

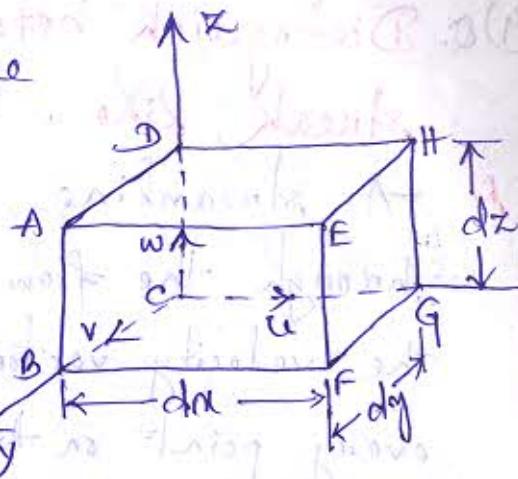
A. Consider a fluid element of length dx, dy and dz in the direction x, y & z and corresponding velocity components u, v and w .

Mass of fluid entering the face ABCD per second

$$= \rho \times \text{velocity in } x$$

$$= \rho \times u \times (\text{Area of } ABCD)$$

$$= \rho \times u \times (dy \times dz)$$



Then mass of fluid leaving the face EFGH per second

$$= \rho u dy dz + \frac{\partial}{\partial x} (\rho u dy dz) dx$$

\therefore Gain of mass in x-direction

$$= \rho u dy dz - \rho u dy dz - \frac{\partial}{\partial x} (\rho u dy dz) dx$$

$$= - \frac{\partial}{\partial x} (\rho u dy dz) dx$$

$$= - \frac{\partial}{\partial x} (\rho u) dx dy dz \quad \{ \because dy dz \text{ is constant?} \}$$

Similarly the net gain of mass in y-direction

$$= - \frac{\partial}{\partial y} (\rho v) dx dy dz$$

$$\text{and in z-direction} = - \frac{\partial}{\partial z} (\rho w) dx dy dz$$

\therefore Net gain of masses

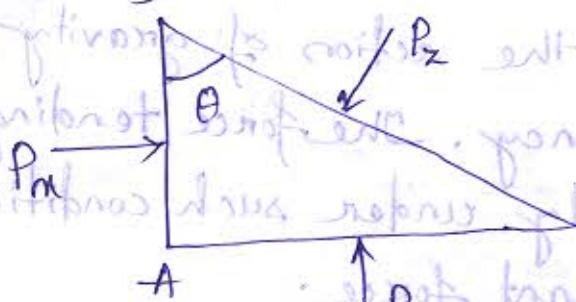
$$= - \left[\frac{\partial}{\partial x} (\rho u) + \frac{\partial}{\partial y} (\rho v) + \frac{\partial}{\partial z} (\rho w) \right] dx dy dz$$

⑥ Q. Define Pascal's Law. 2010

A. This law states the intensity of pressure at a point in a static fluid is the same in all directions.

According to Pascal's Law P_m, P_y, P_z

B



[Pressure of on fluid Element]

Q. How viscosity varies with respect to temperature for gas and liquids? 2010

The relation between viscosity and temperature for liquid and gases are:

$$\text{for liquid, } \mu = \mu_0 \left(\frac{1}{1 + \alpha t + \beta t^2} \right)$$

where, μ_0 = Viscosity of liquid at 0°C , in poise

α, β = are constant for the liquid.

$$\text{for gases, } \mu = \mu_0 + \alpha t - \beta t^2$$

for liquid, the viscosity decreases when temperature increases.

for gases, the viscosity increases when temperature increases. → 2010

Q. Define the term buoyancy and center of buoyancy

When a body is immersed in a fluid either wholly or partially it is subjected to an upward force which tends to lift it up.

This tendency for an immersed body to be lifted up in the fluid, due to an upward force opposite to the action of gravity, is known as buoyancy. The force tending to lift up the body under such conditions is known as buoyant force.

The point of application of the force of buoyancy on the body is known as centre of buoyancy.

Q. Define and explain Newton's Law of viscosity. → 2009, 2010

A. It states that the shear stress (τ) on a fluid element layer is directly proportional to the rate of shear strain.

i.e. $\tau = \mu \frac{du}{dy}$
 where μ = constant of proportionality is called the co-efficient of viscosity.

Q. What do you understand by Total pressure and centre of pressure? → 2009

Total Pressure: It is defined as the force exerted by a static fluid on a surface either plane or curved when the fluid comes in contact with the surface. This force always acts normal to the surface.

Centre of Pressure: It is defined as the point of application of the total pressure acting on the surface of a medium submerged.

With Examples - Water tank, Sluice gate, Channel.

Q. What are the conditions of equilibrium of a floating body and a submerged body?

A. It states that when a body is immersed in fluid either wholly or partially, it is buoyed up by a force which is equal to the weight of the fluid displaced by the body.

(Case-I)

$$W_s > F_B \Rightarrow \frac{\rho_f V}{\rho_f g} + \frac{g}{g} = \rho_f + \frac{\rho_f V}{\rho_f g} + \frac{g}{g}$$

$$\text{or } \rho_f g V_f > \rho_f \text{ liquid } V_g \Rightarrow \rho_f > \rho_f \text{ liquid}$$

$$\rho_s > \rho_f$$

Then body will sink or fall from where it is immersed.

(Case-II) If body sinks in the liquid floating

eg if $W_s < F_B$ goes to work to pull down with

displacing extra fluid in the liquid so

Then body will rise from where it is immersed

extra pressure exerted by displacement of
displaced amount

MODULE - 02

① Q. What is Reynold's number and what is its significance? 2011

A. Reynold's number is defined as the ratio of inertial force of a flowing fluid and the viscous force of the fluid.

Its significance :- It indicates the type of behaviour of flow filament. Whether it is laminar or turbulent.

② Q. Write the Bernoulli's equation for real fluid. 2010

A. The Bernoulli's equation for real fluids between point 1 and 2 is given as,

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + h_2$$

where h_2 is the loss of energy between point 1 and 2.

③ Q. What is the difference between pitot tube & pitot static tube? 2010

A. Pitot tube :- It is a device used for measuring the velocity of flow at any point in a pipe or a channel. It is based on the principle that if the velocity of flow at a point becomes zero, the pressure there is increased due to conversion of kinetic energy into pressure energy.

Pitot Static Tube: It is arrangement to find the velocity at any point in a pipe by help of pitot-tube, which consists of two circular concentric tubes one inside the other with some annular space in between. The outlet of these two tubes are connected to the differential manometer where the difference of pressure head 'h' is measured by knowing the difference of the level of the manometer liquid.

④ Q. State Bernoulli's theorem for steady flow of an incompressible fluid. What are the practical applications of this theorem?

A) It states that, the energy of fluid at any cross-section in a pipe is constant.
The following are the assumption made in the derivation of the Bernoulli's equation:
(i) The fluid is ideal i.e. viscosity is zero
(ii) The flow is steady.
(iii) The flow is incompressible.
(iv) The flow is irrotational.

Applications:

- i) Venturimeter
 - ii) Orifice meter
 - iii) Pitot tube
- IV) If $v_1 = v_2 = 0 \rightarrow$ fluid statics
- V) Torrcelli's theorem (velocity of efflux)

⑤ Q. What is an orifice meter? Write the expression for discharge of a ~~out~~ orifice meter.

A) It is a device used for measuring the rate of flow of a fluid through a pipe.

$$\text{discharge } Q = \frac{C_d a_0 \alpha_1 \sqrt{2gh}}{\sqrt{a_1^2 - a_0^2}}$$

Where

a_0 → area of orifice

α_1 → area of pipe

C_d → Co-efficient of discharge for orifice meter

⑥ Q. Define stream line & stream tube.

A)

⑥ Q. Differentiate between HGL and TEL?

A)

Total Energy Line (TEL): When the fluid flows along the pipe, there is loss of head (energy) and the total energy decreases in the direction of flow. If the total energy at various points of flow along the axis of the pipe is plotted and joined by a line, the line so obtained is called TEL.

Hydraulic Gradient Line (HGL): The sum of potential (or elevation) head and the pressure head, $(\frac{P}{w} + z)$ at any point is called the piezometric head. If a line is drawn joining the piezometric head levels at various points, the line so obtained is called the HGL.

⑦ Q. State Darcy Weisbach and Chezy formula? Imp.

A). Darcy Weisbach formula:-

$$h_f = \frac{4f}{2g} \cdot \frac{LV^2}{d}$$

Chezy formula:-

$$v = C\sqrt{mi}$$

⑧ Q. What is a siphon? Imp.

A). Siphon is a long bent pipe which is used to transfer liquid from a reservoir at a higher elevation to another reservoir at a lower level when the two reservoirs are separated by a hill or high level ground.

⑨ Q. What are the various minor energy losses in pipes? Imp.

A). Following are the minor energy losses in pipes:

1. Loss of head due to sudden enlargement.
2. Loss of head due to sudden contraction.
3. Loss of head at the entrance of a pipe.
4. Loss of head at the exit of a pipe.
5. Loss of head due to an obstruction in a pipe.
6. Loss of head due to bend in the pipe.
7. Loss of head in various pipe fittings.

MODULE - 03

① a. Difference between reaction and impulse turbine. 2011, 2010, 2008

M1. Reaction Turbine

- The available fluid energy is partly converted into KE by a nozzle before it enters the runner of the turbine.
- Water is admitted over the circumference of the wheel.

Impulse Turbine

- The available fluid energy is converted into KE by a nozzle.
- Water may be allowed to enter a part of whole of the wheel circumference.

② a. What is ~~cavitation~~ in turbine? And when does it occur? 2010, 2011

M1 According to Cavitation is defined as the phenomenon of formation of vapour bubbles of a flowing liquid in a region where the pressure of the liquid falls below its vapour pressure and the sudden collapsing of these vapour bubbles in a region of higher pressure.

③ a. What do you mean by overall efficiency of turbine? 2011

M1. Hydraulic efficiency (η_h)

$$\eta_h = \frac{\text{Power delivered to runner}}{\text{Power supplied at inlet}} = \frac{\text{R.P.}}{\text{W.P.}}$$

$$\text{Mechanical efficiency } (\eta_m) = \frac{\text{S.P.}}{\text{R.P.}}$$

Now overall efficiency.

$$\eta_o = \frac{\text{S.P.}}{\text{W.P.}} = \eta_m \times \eta_{\text{friction}}$$

- (4) Q. Define negative slip and percentage of slip of a reciprocating pump. 2010

A). Slip of the pump is defined as the difference between the theoretical discharge and actual discharge of the pump.

$$\text{Slip} = Q_{th} - Q_{act}$$

$$\% \text{ slip} = \frac{Q_{th} - Q_{act}}{Q_{th}} \times 100 = \left(1 - \frac{Q_{act}}{Q_{th}} \right) \times 100$$

$$= (1 - C_d) \times 100$$

where C_d = Co-efficient of discharge.

If actual discharge is more than the theoretical discharge, the slip of the pump will become negative. In that case, the slip of the pump is known as negative slip.

- (5) Q. How does the torque converter differ from a fluid coupling? 2010

A). The fluid coupling is a device used for transmitting power from driving to driven shaft with the help of fluid.

The hydraulic torque converter is a device used for transmitting increased torque to a driven shaft.

Q) What is meant by speed ratio of a Pelton wheel? 2009

Ans) It is the ratio of velocity of wheel (u) to the velocity of jet at inlet ($v_i = \sqrt{2gh}$)

$$\phi = \frac{u}{\sqrt{2gh}}$$

Q) Define the specific speed of a turbine. Write the significance of it. 2009

Ans) Specific speed of a turbine is defined as the speed at which a turbine runs when it is working under a unit head and develops unit power.

$$N_s = \frac{N \sqrt{P}}{H^{5/4}}$$

Significance:

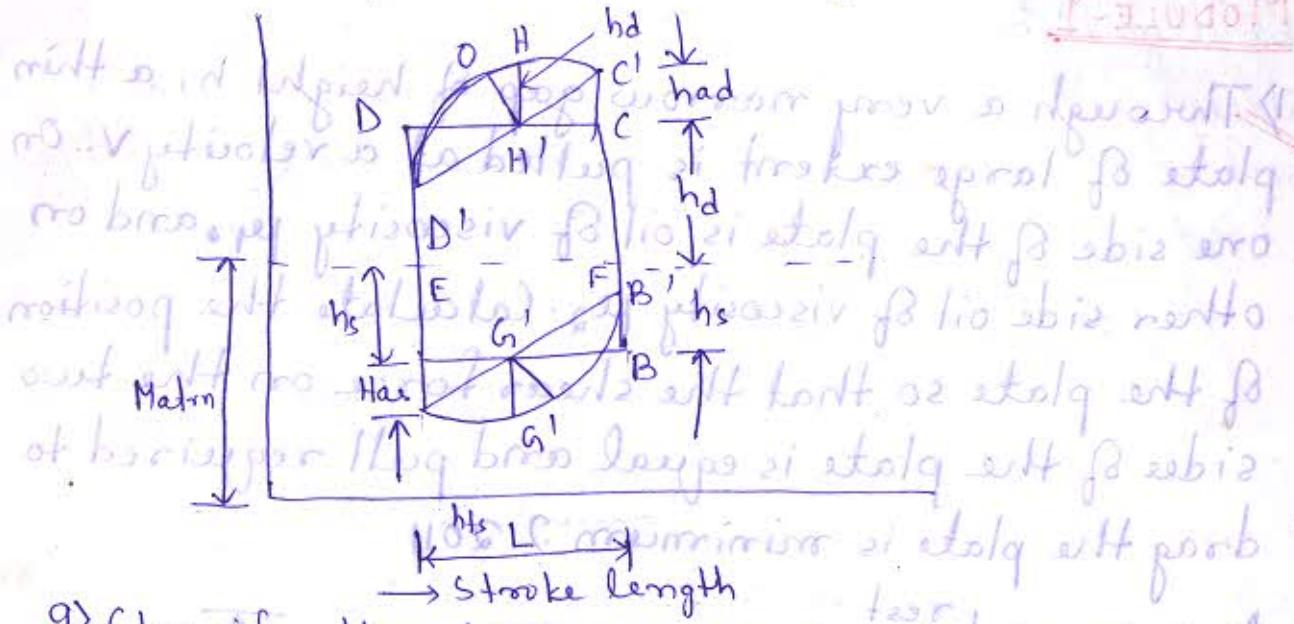
→ To select the type of turbine.

→ To predict the performance of a turbine.

Q) Define indicator diagram. Draw the diagram after consideration of the effect of the acceleration and friction in suction and delivery pipe. → 2009

Ans) The indicator diagram for a reciprocating pump is defined as the graph between the pressure head in the cylinder and the distance

travelled by the piston from inner dead centre for one complete revolution of the crank.



9) Classify the turbine according to the direction of flow of water in the tank. Imp.

Ans) The turbines are classified as:-

- Tangential flow turbine
- Radial flow turbine
- Axial flow turbine
- Mixed flow turbine.

10) What do you mean by governing of a turbine? → Imp.

Ans) It is defined as the operation by which the speed of the turbine is kept constant under all conditions of working.

P.T.O

For minimum cost

$$O = \frac{7b}{id b}$$

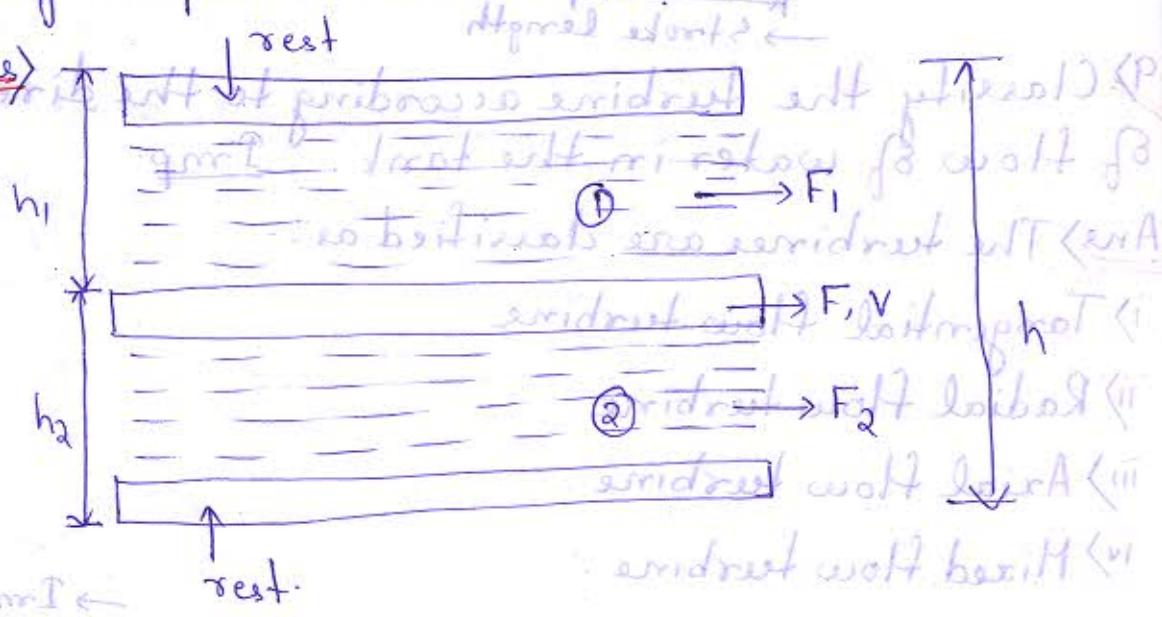
$$\frac{id}{Th} = nk =$$

Long Question

MODULE-1

1) Through a very narrow gap of height h , a thin plate of large extent is pulled at a velocity V . On one side of the plate is oil of viscosity μ_1 and on other side oil of viscosity μ_2 . Calculate the position of the plate so that the shear force on the two sides of the plate is equal and pull required to drag the plate is minimum? [2011]

Ans >



$$F = F_1 + F_2 = \mu_1 A V + \mu_2 A V$$

$$= A V \left[\frac{h_1}{h_1} + \frac{h_2}{h - h_1} \right]$$

For minimum F ,

$$\frac{dF}{dh_1} = 0$$

O.T. 9

$$\Rightarrow h_1 = \frac{h}{\sqrt{\frac{\mu_1}{\mu_2} + 1}}$$

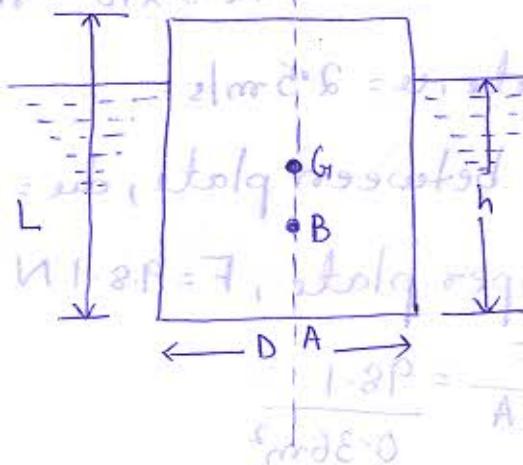
If $\mu_1 = \mu_2$, then, $h_1 = h_2 = \frac{h}{2}$.

~~2) A wooden cylinder of diameter d and length 2d floats in water with axis vertical. Is the equilibrium stable? Locate the metacentre with reference to water surface. Specific gravity of wood is 0.6.~~

2011

Ans) Given $L = 2D$. $\rho_{\text{wood}} = 0.6 \times \rho_{\text{water}}$

Sp. gravity of cylinder $S_1 = 0.6$



Sp. gravity of water $S_2 = 1$

Let the depth of cylinder immersed in oil $= h$

For the principle of buoyancy, weight of cylinder = weight of oil displaced.

$$\frac{\pi}{4} D^2 \times L \times 0.6 \times 1000 \times 9.81 = \frac{\pi}{4} D^2 \times h \times 1 \times 1000 \times 9.81$$

$$\Rightarrow L \times 0.6 = h$$

$$\Rightarrow h = 0.6L$$

~~3) A space between two square flat parallel plates is filled with oil. Each side of the plate is 60cm. The thickness of the oil film is 12.5mm. The upper plate, which moves at 2.5 m/s requires a force of 98.1 N to maintain the speed.~~

→ 2010

Determine,

i) The dynamic viscosity of oil in poise.

ii) The kinematic viscosity of oil in stoke if specific gravity of oil is 0.95.

Ans) Each side of a square plate $60\text{cm} = 0.60\text{m}$.

$$\therefore \text{Area}, A = 0.6 \times 0.6 = 0.36\text{m}^2 \quad (A = 1 \text{ m} \times 1 \text{ m})$$

$$\begin{aligned} \text{Thickness of oil film, } dy &= 12.5 \text{ mm} \\ &= 12.5 \times 10^{-3} \text{ m.} \end{aligned}$$

Velocity of upper plate, $u = 2.5 \text{ m/s}$.

\therefore Change of velocity between plate, $du = 2.5 \text{ m/sec}$

Force required on upper plate, $F = 98.1 \text{ N}$

$$\therefore \text{Shear stress, } \tau = \frac{F}{A} = \frac{98.1}{0.36\text{m}^2}$$

i) Let μ_e = Dynamic viscosity of oil

$\tau = \mu_e \frac{du}{dy}$

$$\Rightarrow \frac{98.1}{12.5 \times 10^{-3}} = \mu_e \times 2.5$$

$$\Rightarrow \mu_e = 1.3635 \text{ Ns/m}^2$$

$$= 13.635 \text{ poise}$$

ii) Specific gravity of oil, $S = 0.95$

Let ν = Kinematic viscosity of oil

Mass density of oil, $\rho = 950 \text{ kg/m}^3$

$$\text{Bouyant reaction} = 0.95 \times 1000 = 950 \text{ kg/m}^3$$

$$V = \frac{\mu e}{f} = \frac{1.3635}{950} \cdot \frac{g}{f} = \frac{1.3635 \cdot g}{950 f}$$

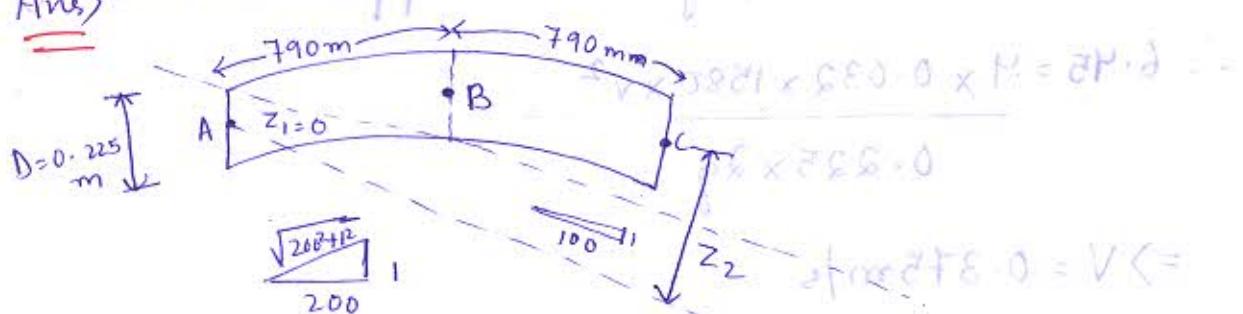
$$= 0.001435 \text{ m}^2/\text{sec}$$

$$= 14.35 \text{ stokes.}$$

MODULE-2 :-

~~D~~A pipeline 0.225 m in diameter and 1580 m long has a slope of 1 in 200 for the first 790 m and 1 in 100 for the next 790 m. The pressure at the upper end of the pipeline is 107.91 kPa and the lower end is 53.955 kPa. Taking $f = 0.032$, determine the discharge through the pipe. 2011

Ans)



Position-1 :-

$$\text{Slope } i_1 = \frac{1}{200}$$

Position-2 :-

$$\text{Slope } i_2 = \frac{1}{100}$$

$AB = 790 \text{ m}$ $i_1 = 1/200$ $i_2 = 1/100$

$$D = 0.225 \text{ m}$$

$$P_1 = 53.955 \text{ kPa}$$

$$P_2 = 107.91 \text{ kPa}$$

$$Z_B = \frac{1}{200} \times 790$$

$$Z_2 = Z_B + \frac{1}{100} \times 790$$

$$= 3.95$$

$$= 3.95 + 7.90 = 11.85$$

$$h_f = \frac{4f L V^2}{g f_x^2} = \frac{4 \times 0.032 \times 1580 \times V^2}{0.225 \times 2 \times g} = 1.12 \times 1580 \times V^2$$

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + h_f$$

$$\therefore \Delta_1 = \Delta_2 \therefore V_1 = V_2$$

$$\left(\frac{P_1 - P_2}{\rho g} \right) - z_2 = h_f$$

paralipomenon estamib mi m866.0 erileqiq A
bopo m8PF leuit wtt out 006 mi l f8 squalo o zan
h_f = $\frac{53.955 \times 10^3}{1000 \times 9.81} - 11.854$ out 001 mi l
bopo o9d IP fol 27.2009ig att f3 boro reggiw att
,680.0 = 5.4 + 11.854 28P.83 si boro maw att
1106.999 6.45 (Give sign due to opposite direction)

$$\therefore 6.45 = 4 \times 0.032 \times 1580 \times V^2$$

$$\Rightarrow V = 0.375 \text{ m/s}$$

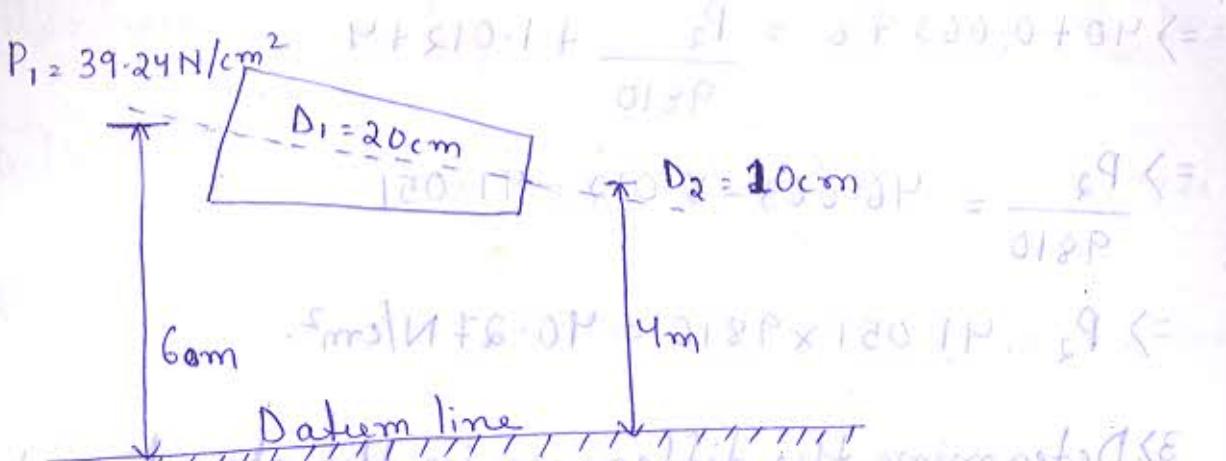
$$Q = AV = \frac{\pi}{4} \times 0.925^2 \times 0.375$$

$$= 0.0149 \text{ m}^3/\text{sec}$$

2) The water is flowing through a pipe having diameters 20cm and 10cm at sections 1 and 2 respectively. The rate of flow through pipe is 35 litres/sec. The section 1 is 6m above datum and section 2 is 4m above datum. If the pressure at section 1 is 39.24 N/cm², find the intensity of pressure at section 2.

Ans) At section 1, $D_1 = 0.2 \text{ m}$

$$A_1 = \frac{\pi}{4} \times (0.2)^2 = 0.0314 \text{ m}^2$$



$$P_1 = 39.24 \times 10^4 \text{ N/m}^2$$

$$Z_1 = 6 \text{ m}$$

At section 2, $D_2 = 0.1 \text{ m}$ with different values

$$A_2 = \frac{\pi}{4} \times D_2^2 = \frac{\pi}{4} \times (0.1)^2 = 0.00785 \text{ m}^2$$

$$Z_2 = 4 \text{ m}$$

$$P_2 = ?$$

$$\text{Rate of flow, } Q = 35 \text{ lit/sec} = 0.035 \text{ m}^3/\text{sec}$$

$$\text{Now, } Q = A_1 V_1 = A_2 V_2$$

$$\therefore V_1 = \frac{Q}{A_1} = \frac{0.035}{0.0314} = 1.114 \text{ m/sec.}$$

$$\text{and } V_2 = \frac{Q}{A_2} = \frac{0.035}{0.00785} = 4.456 \text{ m/sec.}$$

Applying Bernoulli's equation at section 1 and 2, we get,

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

$$\Rightarrow \frac{39.24 \times 10^4}{1000 \times 9.81} + \frac{(1.114)^2}{2 \times 9.81} + 6 = \frac{P_2}{1000 \times 9.81} + \frac{(4.456)^2}{2 \times 9.81} + 4$$

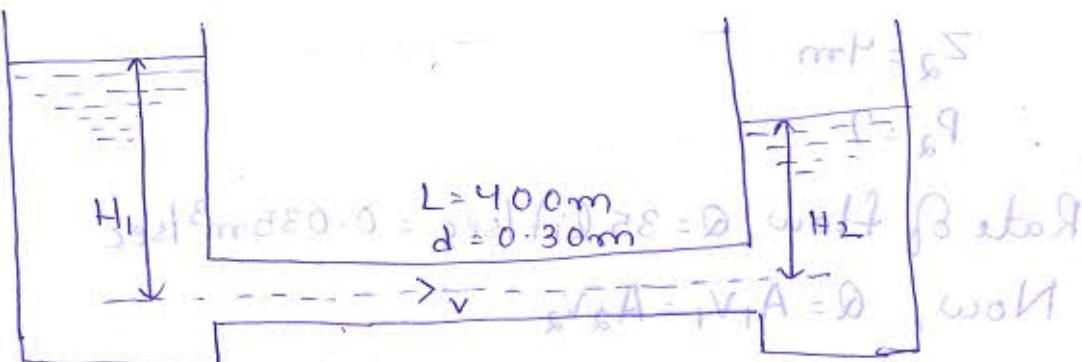
$$\Rightarrow 40 + 0.063 + 6 = \frac{P_2}{9810} + 1.012 + 4$$

$$\Rightarrow \frac{P_2}{9810} = 46.063 - 5.012 = 41.051$$

$$\Rightarrow P_2 = 41.051 \times 9810 = 40.27 \text{ N/cm}^2.$$

3) Determine the difference in the elevations between the water surfaces in the two tanks which are connected by a horizontal pipe of diameter 300mm and length 400m. The rate of flow of water through the pipe is 300 litres/sec. Consider all losses and take the value of $f = 0.008$. Draw the HGL and TEL.

Ans)



$$d = 300 \text{ mm} = 0.30 \text{ m}$$

$$L = 400 \text{ m}$$

$$Q = 300 \text{ lit/sec} = 0.3 \text{ m}^3/\text{s}$$

$$f = 0.008$$

$$\text{Velocity } V = \frac{Q}{\text{Area}} = \frac{0.3}{\frac{\pi}{4} \times (0.3)^2} = 4.244 \text{ m/s}$$

Let two tanks are connected by a pipe as shown in the figure above.

Let H_1 = height of water in the first tank above the centre of pipe.

H_2 = height of water in 2nd tank above the centre of pipe.

Difference in elevations between water surfaces

$$= H_1 - H_2$$

Applying Bernoulli's equation to the free surface of water in the two tanks, we have

$$H_1 = H_2 + \text{losses}$$

$$= H_2 + h_i + H_f + h_o \quad \text{--- (1)}$$

where h_i = Loss of head at entrance = $0.5 \frac{V^2}{2g}$

$$h_o = 0.918 \text{ m} = (0.1 \times 10 \text{ m}) \frac{V^2}{2g} = \frac{0.5 \times 4.244^2}{2 \times 9.81} = 0.459 \text{ m}$$

$$h_f = \text{Loss of head due to friction} = \frac{4 \times f \times L \times V^2}{d \times 2g}$$

$$= \frac{4 \times 0.008 \times 400 \times 4.244^2}{0.3 \times 2 \times 9.81} = 39.16 \text{ m}$$

$$h_o = \text{Loss of head at outlet} = \frac{V^2}{2g} = \frac{4.244^2}{2 \times 9.81} = 0.918 \text{ m}$$

Substituting these values in eqn (1), we get,

$$H_1 = H_2 + 0.459 + 39.16 + 0.918$$

$$3 \text{ m o.d.} = H_2 + 40.537 \quad \text{--- (2)}$$

$$H_1 - H_2 = 40.537 \text{ m (Ans)}$$

Let $H_1 = 50 \text{ m}$ above B water level

$$\Rightarrow H_2 = 9.463 \text{ m}$$

a) T.E.L

→ Point A is on the free surface of water in 1st tank. From A, take $AB = h_i = 0.459\text{ m}$.

→ Draw a horizontal line BF. Take BF equal to the length of pipe. From F, draw a vertical line in the downward direction. Cut FC = $h_f = 39.16\text{ m}$.

→ Join BC. From C take CD = $h_o = 0.918\text{ m}$. The point D should coincide with free surface of water in 2nd tank. That line ABCD is the total energy line.

Diagram - Refer Pg. 494 (Fig 11-10) - R.K. Bansal.

$$18 \cdot P \times S$$

$$= 18 \cdot P \times H \cdot O =$$

$8 \cdot 7 \times 5 \times 7 \times 11 =$ position of sub board of 2nd tank = 1st

$$P \times S$$

$$8 \cdot P \times S \cdot H \times 0.918 \times 800 \cdot O \times P =$$

$$18 \cdot P \times S \times 8 \cdot 9$$

$$H \cdot O \cdot P \times S =$$

$$\frac{8 \cdot P \times S \cdot P}{18 \cdot P \times S} = \frac{P}{18} = \text{position of sub board of 2nd tank} = 3rd$$

b) H.G.L :-

→ From D, draw a line DE parallel to line BC. The line DE is the H.G.L.

$$\text{OR } 8 \cdot P \cdot O + 8 \cdot 1 \cdot P \cdot E + P \cdot S \cdot H = H$$

→ From B, take $BE = \frac{V^2}{2g} = 0.918\text{ m}$ and from E draw a line ED || BC. The point D should coincide with free surface of water in 2nd tank. The line ED is the H.G.L.

$$H \cdot O \cdot P = H \cdot K =$$

MODULE-3 :-

► A pump operates at a maximum efficiency of 82% and delivers $2.25 \text{ m}^3/\text{sec}$ speed under a head of the 18m while running at 3600 rpm speed. Compute specific speed of the pump. Also determine the discharge head and power input to pump at a shaft speed of 2400 rpm. Cite assumptions made if any.

Ans Given, $Q = 2.25 \text{ m}^3/\text{sec}$

$$H = 18 \text{ m}$$

$$\eta_0 = 82\% = 0.82$$

$$N = 3600 \text{ rpm}$$

$$\text{Power } P = \frac{W Q H}{N_0} = \frac{9810 \times 2.25 \times 18}{0.82} = 818.18 \text{ kW}$$

The specific speed is given by,

$$N_s = N \sqrt{Q}$$

$$\Rightarrow Q = 2.25 \text{ m}^3/\text{sec}$$

However, if discharge q is taken in m^3/sec

$$N_s = \frac{3600 \sqrt{2.25}}{(18)^{3/4}} = 618 \text{ rpm}$$

Since $Q \propto N$

$$H \propto N^2 \text{ and } P \propto N^3$$

$$\frac{Q}{N} = \frac{Q_1}{N_1}$$

for water with maximum & no storage giving AS

$$Q_1 = \left(\frac{N_1}{N} \right) Q = \frac{2400}{3600} \times 2.25 = 1.5 \text{ m}^3/\text{s}$$

 being converted to primrose sludge m/s with flow

$$H_1 = \frac{N_1^2}{N^2} H = \frac{(2400)^2}{(3600)^2} \times 18 = 8 \text{ mms ft above}$$

$$\frac{P}{N^3} = \frac{P_1}{N_1^3}$$

$$\therefore P_1 = \left(\frac{N_1}{N} \right)^3 P = \left(\frac{2400}{3600} \right)^3 \times 484.518 = 143.56 \text{ kW.}$$

Assumption - The efficiency remains constant at all the speed.

2) Two jets strike the buckets of a Pelton wheel which is having shaft power as 15450 kW. The diameter of each jet is given as 200mm. If the net head on the turbine is 400m, find the overall efficiency of the turbine? 2010

Ans Given, shaft power = 154.50 kW

$$\text{Number of jets} = 2$$

$$\text{Shaft power S.P.} = 154.50 \text{ kW}$$

$$\text{Diameter of each jet, } d = 200 \text{ mm} = 0.2 \text{ m.}$$

Area of each jet, $A = \frac{\pi}{4} d^2$ ~~waterwork oskaro~~
 eff. head 38.0 ~~is 200~~ eff. ~~for water head - 32.0~~
~~eff. area of each jet~~ $= 0.031416 \text{ m}^2$

Net head, $H = 400 \text{ m}$.

~~Power = pressure eff. for~~

Let, co-efficient of velocity $C_v = 1.0$

Velocity of each Jet,

$$V_1 = C_v \sqrt{2gh}$$

$$0.8 \times 1000 \times 9.81 = 9.81$$

$$= 1 \sqrt{2 \times 9.81 \times 400} = H_{\text{base}}$$

$$= 88.58 \text{ m/s} \quad \text{other base}$$

Discharge of each jet, $= A \times V_1$

$$= 0.031416 \times 88.56 = 1 \text{ m}^3/\text{s}$$

$$= 2.78 \text{ m}^3/\text{s}$$

$$\text{dim 8.3.36} =$$

\therefore Total discharge $Q = 2 \times 2.78$

$$= 5.56 \text{ m}^3/\text{s}$$

Power at the inlet of turbine, H_{base}

$$W.P = \frac{f \times g \times Q \times h}{1000} = \frac{1000 \times 9.81 \times 5.56 \times 400}{1000} = 19.81 \text{ KW}$$

$$= \frac{1000 \times 9.81 \times 5.56 \times 400}{1000} = 19.81 \text{ KW}$$

$$= 21817.44 \text{ KW}$$

$$\eta_o = \frac{S.P}{W.P} = \frac{15450}{21817.44} = 0.708$$

$$= 0.708 \times 100\% = 70.8\%$$

3) A Kaplan turbine develops 9000 KW under a net head of 7.5 m . Mechanical efficiency of the wheel is 86% . The speed ratio based on

The outer diameter is 2.2 and the flow ratio is 0.66. Diameter of the boss is 0.35 times the external diameter of the wheel. Determine the diameter of the runner and the specific speed of the runner. 2009

Ans) Here mechanical efficiency means the overall turbine efficiency.

$$S.P = 9000 \text{ KW}$$

$$\text{Head, } H = 7.5 \text{ m}$$

$$\text{Speed ratio, } \frac{u_1}{\sqrt{2gh}} = 2.2$$

$$\Rightarrow u_1 = 2.2 \times \sqrt{2 \times 9.81 \times 7.5} \\ = 26.68 \text{ m/s}$$

$$\text{Flow ratio, } \frac{V_{f1}}{\sqrt{2gH}} = 0.66$$

$$\Rightarrow V_{f1} = 0.66 \times \sqrt{2 \times 9.81 \times 7.5} \\ = 8 \text{ m/s}$$

$$\text{Diameter of boss} = 0.35 \times D_o$$

$$\eta_m = 90\% = 0.90$$

$$\Rightarrow 0.90 = \frac{9000 \times 1000}{0.9 \times 1000 \times 9.81 \times 7.5} = \frac{9.2}{9.0} = 0.5$$

$$= 135.91 \text{ m}^3/\text{sec}$$

$$Q = \frac{\pi}{4} (D_o^2 - D_b^2) \times V_{f1}$$

$$\Rightarrow 135.91 = \frac{\pi}{4} [D_o^2 - (0.35 D_o)^2] \times 8$$

$$= \frac{\pi}{4} \times 0.8775 D_o^2 \times 8$$

$$\Rightarrow D_o = 4.96 \text{ m}$$

$$D_b = 0.35 \times 4.96 \\ = 1.73 \text{ m}$$

$$\text{Speed of the turbine } \omega_1 = \frac{\pi D_o N}{60}$$

$$\Rightarrow 26.68 = \frac{\pi \times 4.96 \times N}{60}$$

$$\Rightarrow N = 102.78 \text{ rpm}$$

$$N_s = \frac{N \sqrt{P}}{H^{5/4}}$$

$$= \frac{102.78 \times \sqrt{9000}}{(7.5)^{5/4}}$$

$$= \frac{102.78 \times 94.86}{12.4115}$$

$$= 785.60 \text{ rpm}$$