

Unit - 1

Fluid Mechanics

- ① Density =  $\frac{m}{v}$
  - ② specific wt or weight density =  $\frac{\text{wt. of fluid}}{\text{volume of fluid}} = \frac{mg}{V}$
  - ③ specific volume =  $\frac{1}{\rho} = \frac{\text{volume of fluid}}{\text{mass of fluid}}$
  - ④ specific gravity :-  $S = \frac{\text{wt. density of fluid}}{\text{wt. density of water}}$
- wt. density of liquid =  $S \times 9.81 \times 10^3 \text{ N/m}^3$

Prob 1.15

distance of vorten from plate = 20 cm,  
 velocity of vorten =  $u = 120 \text{ cm/sec}$ ,  
 $\mu = 8.5 \text{ poise} = 0.85 \text{ N.s/m}^2$

The velocity profile is given by a parabolic eqn

$u = ay^2 + by + c$  — (i)

The values of constants a, b & c can be obtained from boundary conditions which are as follows.

- (i) when  $y = 0, u = 0$
- (ii) when  $y = 20 \text{ cm}, u = 120 \text{ cm/sec}$
- (iii) when  $y = 20, \frac{du}{dy} = 0$

Putting boundary condition (i) in eqn (i) we get  $c = 0$   
 Putting " " " " (ii) in " " " " we get

Putting b, c (c) in eqn (i) — (ii)  
 $120 = 400a + 20b$

$\frac{du}{dy} = 2ay + b$

$0 = 40a + b$  — (iii)  $\therefore b = -40a$

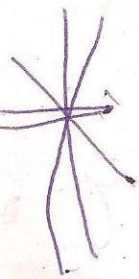
Putting in eqn (ii)

$120 = 400a - 800a \Rightarrow 120 = -400a$

$a = -0.3$

Putting in (iii) :  $b = 12$

Putting values of a, b, & c in (i) we get





$$u = -0.3y^2 + 12y$$

$$\frac{du}{dy} = -0.6y + 12$$

$$\left(\frac{du}{dy}\right)_{at y=0} = 12 \quad \left(\frac{du}{dy}\right)_{at y=20} = 0$$

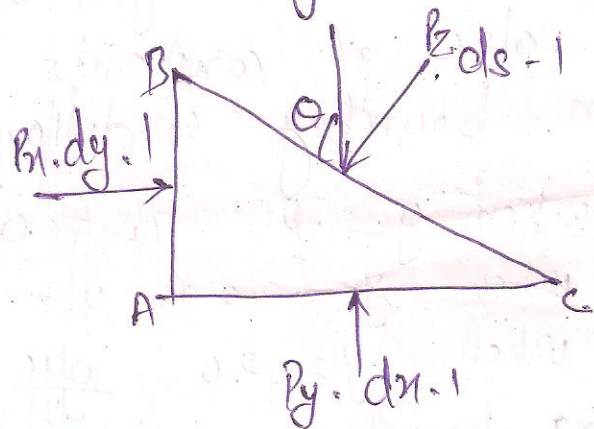
$$(17)_{at y=10} = 6$$

$\tau = \mu \frac{du}{dy}$   $\tau$  can be calculated for above three.

\* Pascal's Law :— It states that the pressure or intensity of pressure at a point in a static fluid is equal in all directions, let the element is very small dimensions  $dx$ ,  $dy$  and  $dz$ .

Let the width of the element is ~~very small~~  $\perp$  to the plane of paper is unity.

$P_x$ ,  $P_y$  &  $P_z$  are intensities of pressure at AB, AC & BC. Forces acting on the faces.



Force on face AB

$$= P_x \cdot dy \cdot 1$$

Force on face AC

$$= P_y \cdot dx \cdot 1$$

~~Force~~ on BC =  $P_z \cdot ds \cdot 1$

Weight of element = mass  $\times g$  = Volume  $\times \rho \times g$   
 $= \frac{AB \times AC}{2} \times \rho \times g$

Resolving the forces in  $x$ -direction

$$P_x \cdot dy \cdot 1 - P_z (ds \cdot 1) \sin(90^\circ - \theta) = 0$$

$$P_x \cdot dy \cdot 1 - P_z \cdot ds \cdot \cos \theta = 0$$

$$ds \cdot \cos \theta = AB = dy$$

$$P_x \cdot dy = P_z \cdot dy \Rightarrow \therefore P_x = P_z$$

Resolving in vertical direction

$$P_y \cdot dx \cdot 1 - P_z \cdot ds \cdot 1 \cos(90^\circ - \theta) = \frac{dx \cdot dy}{2} \times \rho \times g = 0$$