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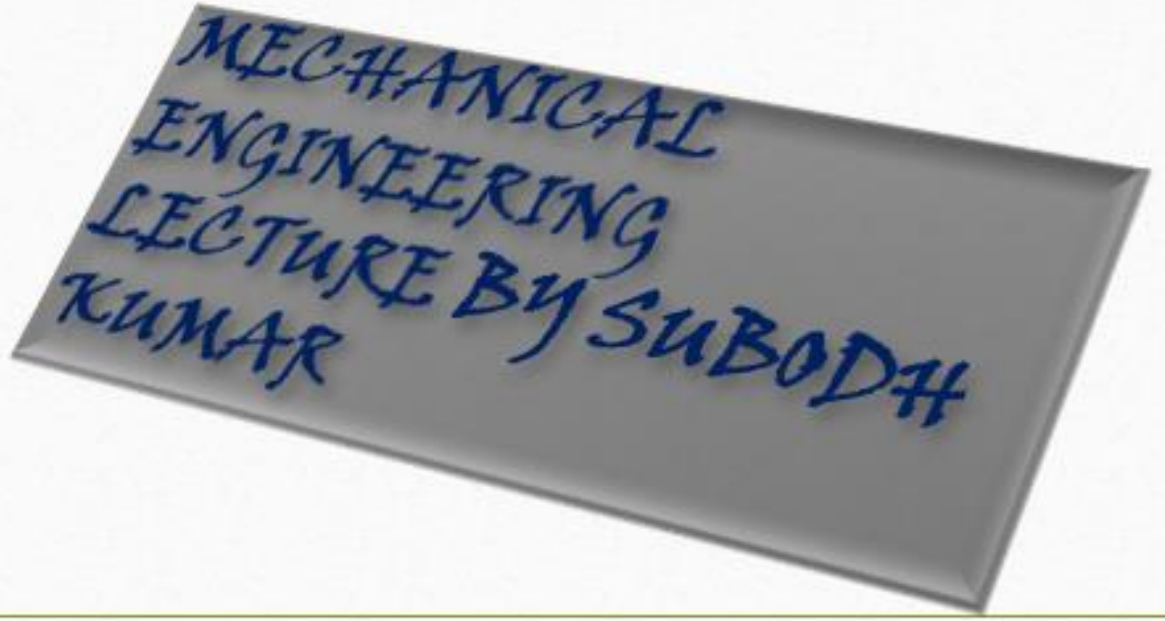

Question 1.3

If the velocity distribution over a plate is given by $u = \frac{2}{3}y - y^2$ in which u is the velocity in m/s at a distance y metre above the plate, determine the shear stress at $y = 0$ and $y = 0.15$ m. Take dynamic viscosity of fluid as 8.63 poises.

Soln

$$u = \frac{2}{3}y - y^2$$

$$\frac{du}{dy} = \frac{2}{3} - 2y \qquad \text{——— (1)}$$

$$\left(\frac{du}{dy}\right)_{y=0} = \frac{2}{3} - 2\times 0$$

$$\boxed{\left(\frac{du}{dy}\right)_{y=0} = \frac{2}{3} = 0.667}$$

$$\left(\frac{du}{dy}\right)_{y=0.15} = \frac{2}{3} - 2\times 0.15$$

$$\boxed{\left(\frac{du}{dy}\right)_{0.5} = \frac{2}{3} - .30 = 0.367}$$

Viscosity $\mu = 8.63$ poise

1 poise $= \frac{1}{10} \frac{Ns}{m^2}$

$$\mu = \frac{8.63}{10} \frac{Ns}{m^2}$$

$$\boxed{\mu = 0.863 \frac{Ns}{m^2}}$$

Now the shear stress $\tau = \mu\left(\frac{du}{dy}\right)$

(i) Shear stress at $y = 0$ is given by

$$\tau_0 = \mu\left(\frac{du}{dy}\right)_{y=0} = 0.863 \times 0.667$$

$$= 0.5756 \ N/m^2 \quad \underline{\text{Ans}}$$

(ii) Shear stress at $y = 0.15$ m is given by

$$(\tau)_{0.15} = \mu\left(\frac{du}{dy}\right)_{y=0.15}$$

$$= 0.863 \times 0.367$$

$$= 0.3167 \ N/m^2$$

Question 1.7

Calculate the dynamic viscosity of an oil, which is used for lubrication between a square plate of size 0.8m × 0.8m and an inclined plane with angle of inclination 30° as shown in fig. The weight of the square plate is 300N and it slides down the inclined plane with a uniform velocity of 0.3 m/s. The thickness of oil film is 1.5mm.

Soln

Area of plate $A = 0.8 \times 0.8 = 0.64 m^2$

Angle of plane $\theta = 30°$

weight of plate, $W = 300 N$

Velocity of plate $u = 0.3 m/s$

Thickness of oil film $(t) = (dy) = 1.5mm = 1.5 \times 10^{-3} m$

Component of weight W, along the plane $= W \sin 30°$

$= 300 \frac{1}{2}$

Thus shear force on the bottom surface of the plate $= 150 N$

$$\tau = \frac{F}{\text{Area}} = \frac{150}{0.64} \ N/m^2$$

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

du = change in velocity $= u - 0 = u = 0.3$ m/s

$dy = t = 1.5 \times 10^{-3}$ m

$$\frac{150}{0.64} = \mu \frac{0.3}{1.5 \times 10^{-3}}$$

$$\mu = \frac{150 \times 1.5 \times 10^{-3}}{0.64 \times 0.3}$$

$$\boxed{\mu = 1.17 \frac{Ns}{m^2}}$$ Ans

$$1 \text{ poise} = \frac{1}{10} \frac{Ns}{m^2}$$

$$\mu = 1.17 \times 10$$

$$\boxed{\mu = 11.7 \text{ Poise}}$$ Ans

Question 1.13 The velocity distribution for flow over a flat plate is given by $u = \frac{3}{4}y - y^2$ in which u is the velocity in metre per second at a distance y metre above the plate. Determine the shear stress at $y = 0.15$m. Take dynamic viscosity of fluid as 8.5 poise.

Soln

$$u = \frac{3}{4}y - y^2$$

diff w.r to y

$$\frac{du}{dy} = \frac{3}{4} - 2y$$

$$\left(\frac{du}{dy}\right)_{0.15} = \frac{3}{4} - 2 \times 0.15$$

$$= 0.75 - 0.30$$

$$\boxed{\left(\frac{du}{dy}\right)_{0.15} = 0.45}$$

Viscosity $\mu = 8.5$ poise $= \frac{8.5}{10} \frac{Ns}{m^2}$

$$\tau = \mu \frac{du}{dy} = \frac{8.5}{10} \times 0.45 \frac{N}{m^2}$$

$$\boxed{\tau = 0.3825 \text{ N/m}^2}$$ Ans

THANKYOU