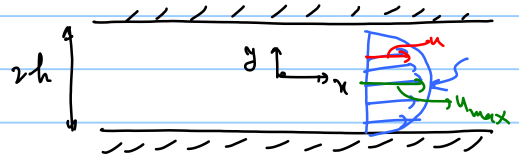
سیالات ۱ - یکشنبه ۱۴/۲/۹۹

2.34)

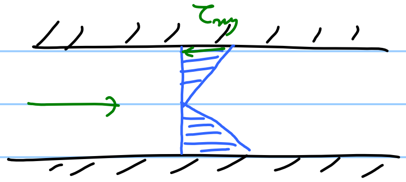


$$\frac{u}{u_{max}} = 1 - \left(\frac{2y}{h}\right)^2$$

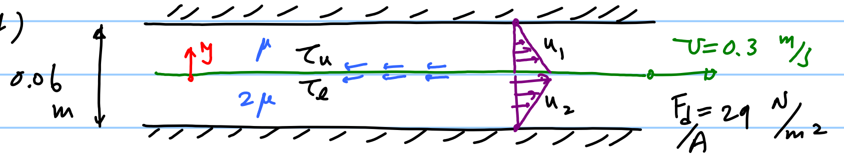
$$\tau_{xy} = \mu \frac{\partial u}{\partial y} = \cancel{\mu}\, \cancel{u_{max}} \left(\frac{8y}{\cancel{h}^2}\right) \Rightarrow \tau_{xy}(y) \checkmark$$

0.1 m/s $\quad h = 0.1$ mm

از تنزورها و جداول
صفحه آخر کتاب



2.37)



$F_d/A = 29 \; N/m^2$

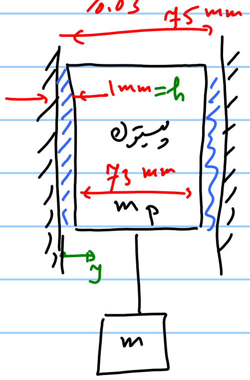
μ = ?

$$F_d = (\tau_u + \tau_l)A \Rightarrow F_d/A = \tau_u + \tau_l = 29$$

$$\mu \cancel{\frac{\partial u_1}{\partial y}}\Big|_{y=0} + 2\mu \cancel{\frac{\partial u_2}{\partial y}}\Big|_{y=0} = 29 \Rightarrow \checkmark \boxed{\mu}$$

$\frac{0.3}{0.03} \qquad \frac{0.3}{0.03}$

2.40)



در تعادل :

$$F_v = W_p + W \checkmark$$

$$F_v = \tau A$$

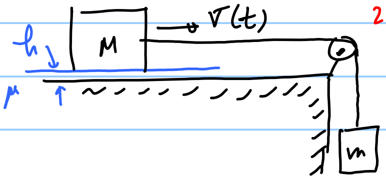
$$= \left(\mu \cancel{\frac{\partial u}{\partial y}}\Big|_{y=h}\right)(\pi D_p L)$$

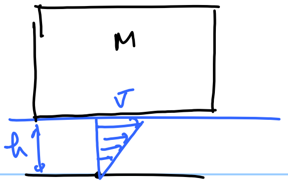
$\frac{V}{h}$

$$W_p = m_p g \;,\quad m_p = \rho_p \forall = \cancel{(SG)}(\cancel{\rho_{H_2O}})\cancel{\forall_p} \checkmark$$

2.64 $\quad$ 1000 $\quad \left(\frac{\pi}{4} D_p^2\right) L_p$

2.45)





$$F_v = \tau A = \left(\mu \cancel{\frac{\partial u}{\partial y}}\Big|_{y=h}\right) A$$

v/h

$$\Rightarrow \boxed{F_v = \frac{\mu v A}{h}}$$

قانون دوم نیوتن : $\sum F_{ext} = (M_{tot})\, a$

$$mg - F_v = (M+m)\frac{dv}{dt}$$

$$\Rightarrow \boxed{(M+m)\frac{dv}{dt} + \frac{\mu A}{h} v = mg}$$ ODE

$$\Rightarrow \frac{dv}{dt} + \underbrace{\frac{\mu A}{h(M+m)}}_{p} v = \underbrace{\frac{m}{M+m} g}_{f}$$

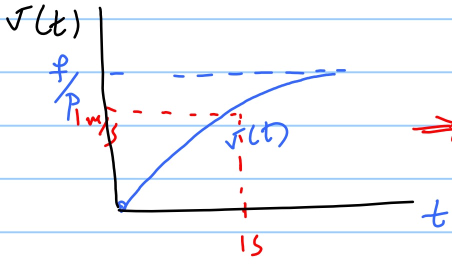
$v' + pv = f$ عامل انتگرال $q = e^{\int p\, dt}$

$$\Rightarrow v(t) = \frac{1}{q}\int q f\, dt + \frac{c}{q}$$

$$\Rightarrow v(t) = \frac{f}{p} + c\, e^{-pt}$$

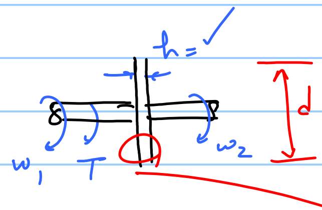
شرط اولیه : $v(0) = 0 \Rightarrow 0 = \frac{f}{p} + c \Rightarrow c = \frac{f}{p}$

$$\Rightarrow v(t) = \frac{f}{p}\left(1 - e^{-pt}\right) \quad , \begin{cases} p = \dfrac{\mu A}{h(M+m)} \checkmark \\ f = \dfrac{m}{M+m} g \checkmark \end{cases}$$



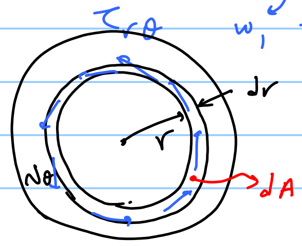
$\Rightarrow \mu$ ✓

2.49)

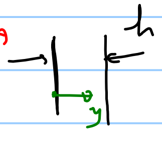


سرعت لغزش

$\Omega = \omega_1 - \omega_2$



$$\tau_{r\theta} = \mu \frac{\partial u}{\partial y}\Big|_{y=h}$$



$v_\theta = \Omega r$

$$\Rightarrow \tau_{r\theta} = \mu \frac{V_\theta}{h} = \underline{\frac{\mu \Omega}{h} r}$$

$$dF = \tau_{r\theta}\, dA = \frac{\mu \Omega}{h} r\, (2\pi r)\, dr$$

$$dT = r\, dF = \frac{2\pi \mu \Omega}{h} r^3\, dr$$

$$\Rightarrow T = \int dT = \int_0^R \frac{2\pi \mu \Omega}{h} r^3\, dr$$

$$\Rightarrow \underline{T = \frac{2\pi \mu \Omega}{h} \frac{R^4}{4}} \quad , \quad \underline{\Omega = \omega_1 - \omega_2}$$