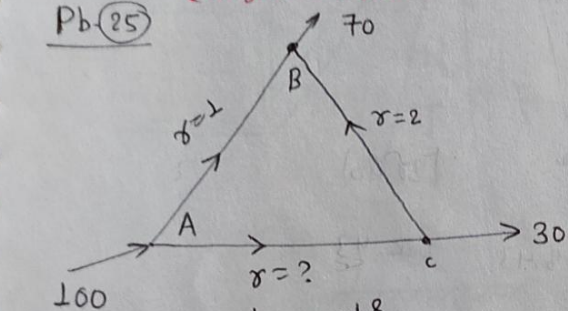
lecture 15
10/04/19

elastic pipe $\frac{P}{\rho g} = \frac{V}{g}\sqrt{\frac{K}{\rho\left(1+\frac{DK}{Et}\right)}}$

(May be come) for ESE

Pb-25



$h_f = r\,Q^{1.8}$

For closed loop

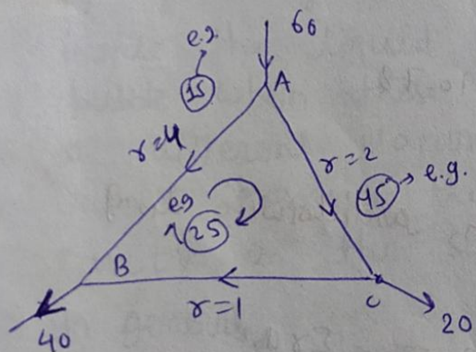
$\Sigma h_r = 0$

$(1)(50)^{1.8} - 2(20)^{1.8} - r(50)^{1.8} = 0$

$\boxed{r = 0.615}$

Network Prob.

Hardy - cross method :-



Determine discharge in each pipelines.

$h_f = \frac{8Q^2}{\pi^2 g}\cdot\frac{fL}{D^5} \Rightarrow r$ $\boxed{h_f = r \cdot Q^2}$

Assume, Discharge in pipe line $= Q_0$

Correction in discharge $= \Delta Q$

Corrected discharge $= Q_0 + \Delta Q$

for closed loop ★★★★

$\Sigma h_f = 0$

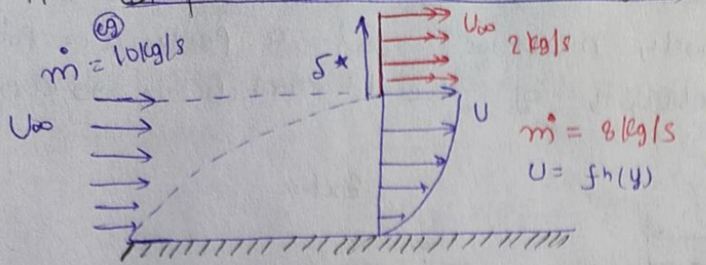
$\Sigma r(Q_0 + \Delta Q)^2 = 0$

$\Sigma r(Q_0^2 + \cancel{\Delta Q^2} + 2Q_0\Delta Q) = 0$ (high)

$$\boxed{\Delta Q = \frac{-\Sigma r Q_0^2}{\Sigma |2 r Q_0|}}$$

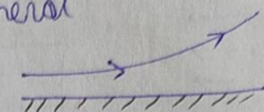
Displacement thickness (δ^*)

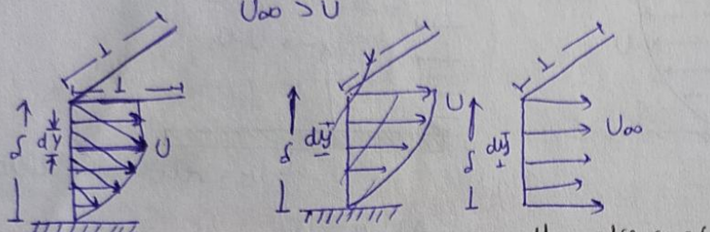
Imp. for ESE



[Assume
width = 1
Mass flow rate = $\rho \times$ Area $\times$ velocity]

In general





In the Presence of boundary layer

In the absence of boundary layer

Mass flow rate in the absence of boundary layer 10 kg/s

$$= \int_0^\delta \rho (dy.1).U_\infty$$

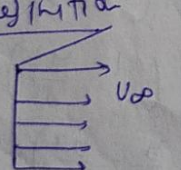
Mass flow rate in the presence of boundary layer 8 kg/s

$$= \int_0^\delta \rho (dy.1) U$$

Reduction in mass flow rate $= \int_0^\delta \rho (U_\infty - U)\, dy$ -- ①

2 kg/s

By definition



Compensation in mass flow rate

$$= \rho (\delta^* .1).U_\infty$$ -- ②

By eq ① and ②

$$\cancel{\rho}(\delta^* .1) U_\infty = \int_0^\delta \cancel{\rho} (U_\infty - U)\, dy$$

$$\boxed{\delta^* = \int_0^\delta \left[1 - \frac{U}{U_\infty}\right] dy}$$ ✓

It is defined as the distance, measured ⊥ to the boundary of the solid body, by which the boundary should be displaced to compensate for reduction in mass flow rate on account of boundary layer formation.

Pb 30

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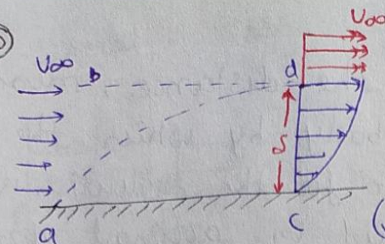

Determine $\frac{\dot{m}_{bd}}{\dot{m}_{ab}} = ??$ Given, $\frac{U}{U_\infty} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$

(Assume width = 1)

$$\frac{\dot{m}_{bd}}{\dot{m}_{ab}} = \frac{\cancel{\rho}(\delta^* \cdot 1)\cdot \cancel{U_\infty}}{\cancel{\rho}(\delta \cdot 1)\cancel{U_\infty}} = \frac{\delta^*}{\delta} = \frac{\frac{\delta}{3}}{\delta} = \frac{1}{3}$$

$$\delta^* = \cancel{\delta}\int_0^\delta \left(1 - \frac{U}{U_\infty}\right) dy$$

$$= \int_0^\delta \left(1 - 2\left(\frac{y}{\delta}\right) + \left(\frac{y}{\delta}\right)^2\right) dy$$

$$= \left(y - \frac{2y^2}{2\delta} + \frac{y^3}{3\delta^2}\right)_0^\delta = \delta - \delta + \frac{\delta}{3} = \boxed{\frac{\delta}{3}}$$