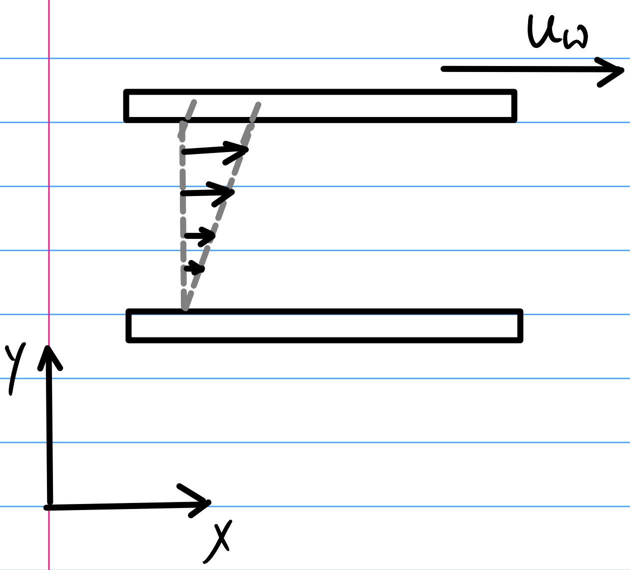
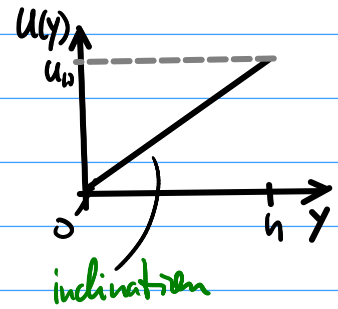
Chap 5, p. 3





$$u(y) = \frac{u_\omega}{h}\, y$$

$$= u_\omega \frac{y}{h}$$

Taylor-Series: for $x \ll 1$

$$\sin x = x - \frac{x^3}{3!} \pm \dots$$

$$\cos x = 1 - \frac{x^2}{2} \pm \dots$$

$$\tan x = \frac{\sin x}{\cos x} \approx \frac{x - \cancel{x^3/3!}}{1 - \cancel{x^2/2}}$$

$x = 0.1$
$x^2 = 0.01$
$x^3 = 0.001$

$$\approx x \quad \text{for } x \ll 1 \qquad x \text{ in radians}$$

from p. 4: $\frac{u_\omega \cdot \Delta t}{h} \approx \Delta\gamma \quad \Big| : \Delta t$

$$\dot{\gamma} = \frac{\Delta\gamma}{\Delta t} = \underbrace{\frac{u_\omega}{h}}_{\text{see } u(y) \text{ above}} = \frac{du}{dy}$$

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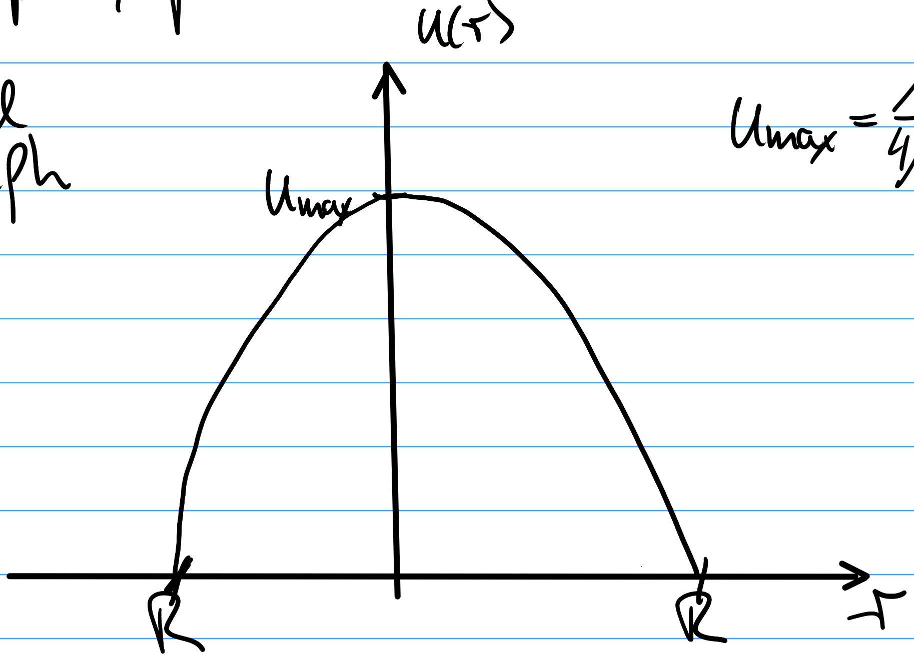
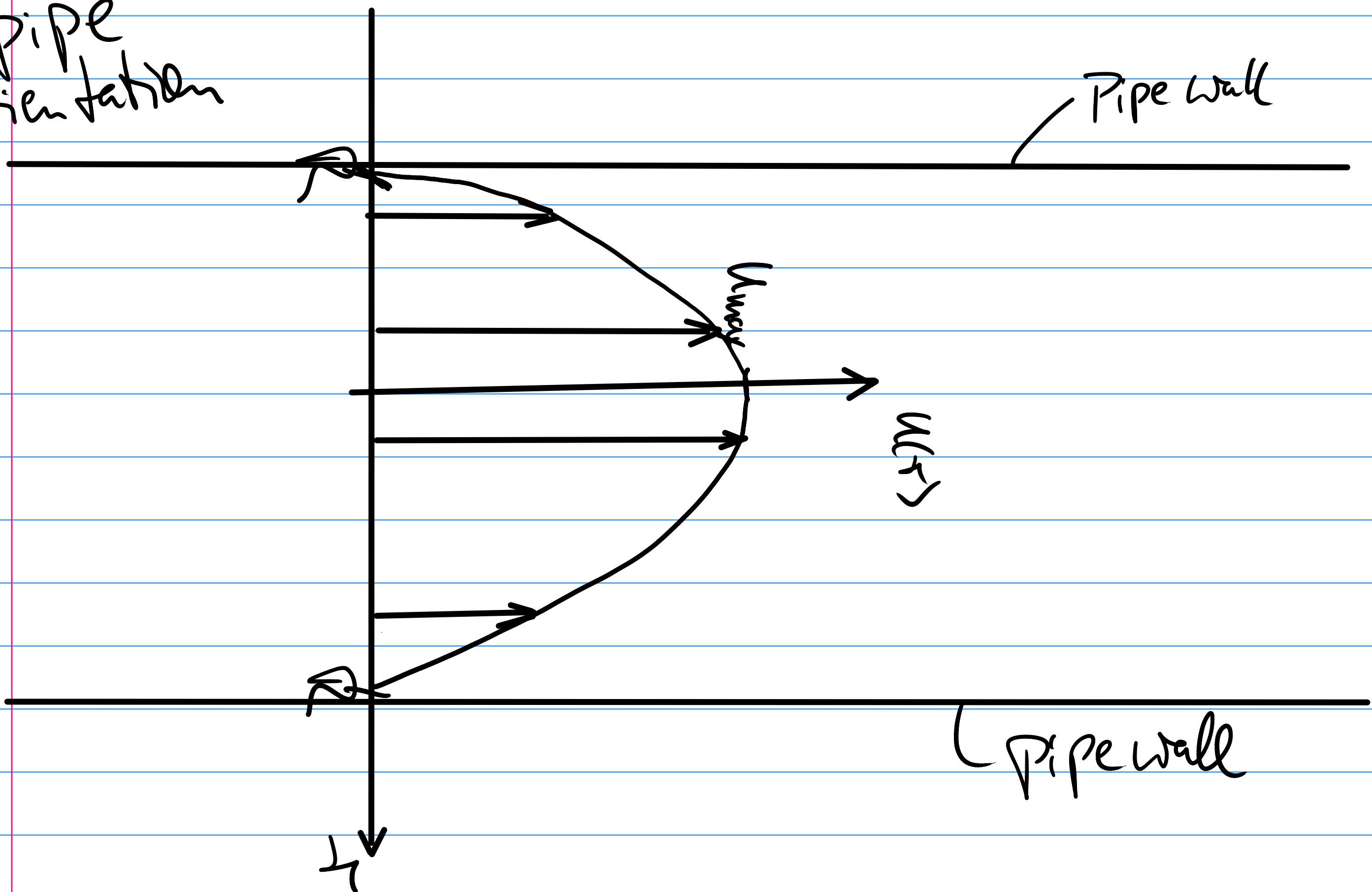
usual graph

$u_{max} = \frac{1}{4\mu} \frac{P_1 - P_2}{L} R^2$



in pipe orientation



What is the volume flow rate?

u is not constant across the area!

$\Rightarrow \dot{V} = u \cdot A$ is not possible! $\rightarrow$ p. 25

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$$\dot{V}_0 = \frac{\pi}{8\mu} \frac{p_1 - p_2}{L} R_0^4$$

What R_1 for doubling the volume flow rate?

$$\dot{V}_1 = \cancel{\frac{\pi}{8\mu}} \cancel{\frac{p_1 - p_2}{L}} R_1^4$$
$$= 2\dot{V}_0 = 2 \cancel{\frac{\pi}{8\mu}} \cancel{\frac{p_1 - p_2}{L}} R_0^4$$

$$\Rightarrow R_1^4 = 2 R_0^4 \qquad \left(\sqrt[4]{} \right)$$
$$R_1 = \sqrt[4]{2}\, R_0$$
$$= 1{,}189\ldots R_0$$
$$\approx 1.2\, R_0$$

p. 26

$$\bar{u} = \frac{\dot{V}_{real}}{A_{pipe}} \Rightarrow \dot{V} = \bar{u} A_{pipe}$$

average velocity

as before

... but need <u>average</u> velocity.