1) See HW3 Hint document

$$\boxed{C_d = 3.62}$$

2)

I watched these videos

<your summary>

3) Vorticity field at

$$U = y + \cos(x)$$
$$V = \sqrt{x} + \sin(x)$$

$$\omega = \nabla \times V = \frac{dv}{dx} - \frac{du}{dy}$$

$$\frac{dv}{dx} = \frac{d}{dx}\left(x^{1/2}\right) = \frac{1}{2} x^{-1/2}$$

$$\frac{du}{dy} = \frac{d}{dy}(y) = 1$$

$$\boxed{\omega = \frac{1}{2} x^{-1/2} - 1}$$

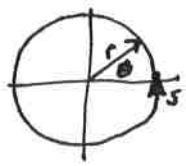
This field conceptually represents a boundary layer (near the wall)

4) Flow field

$$U_r(r,\theta) = \frac{\Lambda}{2\pi r}$$

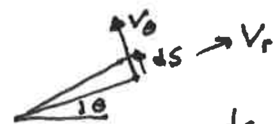
$$U_\theta(r,\theta) = \frac{\Gamma}{2\pi r}$$

- Circulation about unit circle



parameterize s : $r = R = 1$, $\theta = 0 \,..\, 2\pi$

$$\Gamma = -\oint V \cdot d\vec{S}$$ and



$ds = r\,d\theta$

$$= -\oint V_\theta \, ds$$

$$= -\int_0^{2\pi} V_\theta \, r \, d\theta$$

$$= -\int_0^{2\pi} \frac{\Gamma}{2\pi R} R \, d\theta = -\frac{\Gamma}{2\pi}\int_0^{2\pi} d\theta = -\Gamma_{vortex}$$

Circulation = strength of vortex

- Divergence

$$\sigma = \nabla \cdot V = \frac{1}{r}\frac{d}{dr}(rV_r) + \frac{1}{r}\frac{d}{d\theta}(V_\theta) = \frac{1}{r}\frac{d}{dr}\left(\frac{r\Lambda}{2\pi r}\right)^{\to 0} + \frac{1}{r}\frac{d}{d\theta}\left(\frac{\Gamma}{2\pi r}\right)^{\to 0}$$

$$= 0$$

- Rotational / Irrotational

$\omega = 0$ everywhere <u>but</u> $r = 0$