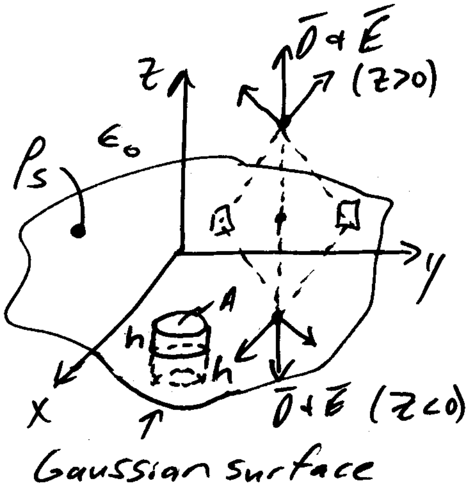
Example- Using Gauss' Law, find the electric flux density and electric field vectors due to an infinite sheet of uniform surface charge on the *x-y* plane in free space.



* By symmetry, we expect $\bar{D}$ + $\bar{E}$ to only have z-components
* At a fixed distance/height from the x-y plane, we expect $|\bar{D}|$ = constant + $|\bar{E}|$ = constant

Based on these observations, select a cylinder w/ top + bottom @ $z = \pm h$ and area A whose sides are orthogonal to x-y plane to be the <u>Gaussian surface</u>.

Gauss' Law $\oint\!\!\oint_S \bar{D} \cdot d\bar{s} = Q_{enc}$

$$\iint_{Top} \hat{a}_z D_z \cdot +d\bar{s}_z + \iint_{Bott} -\hat{a}_z D_z \cdot -d\bar{s}_z + \iint_{side} \underbrace{\pm \hat{a}_z D_z \cdot d\bar{s}_{side}}_{\to 0} = Q_{enc}$$

$$D_z \underbrace{\iint_{Top} ds_z}_{\to A} + D_z \underbrace{\iint_{Bott} ds_z}_{\to A} + 0 = \rho_s A$$ ← 'punched out' circle of ρ_s

$$2 D_z A = \rho_s A \Rightarrow D_z = \frac{\rho_s}{2}$$

$$\boxed{\bar{D} = \begin{cases} \hat{a}_z \frac{\rho_s}{2} & z > 0 \\ -\hat{a}_z \rho_s/2 & z < 0 \end{cases}} \qquad \boxed{\bar{E} = \bar{D}/\epsilon_0 = \begin{cases} \hat{a}_z \frac{\rho_s}{2\epsilon_0} & z > 0 \\ -\hat{a}_z \frac{\rho_s}{2\epsilon_0} & z < 0 \end{cases}}$$

In general, for any infinite flat plane of uniform ρ_s,

<u>$\bar{D} = \hat{a}_n \rho_s/2$</u> + <u>$\bar{E} = \hat{a}_n \frac{\rho_s}{2\epsilon_0}$</u> where $\hat{a}_n$ is surface normal to plane.