2.2 Find NP_{sf}
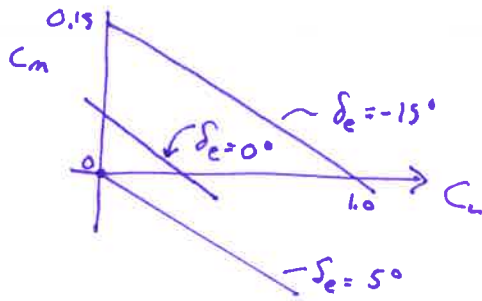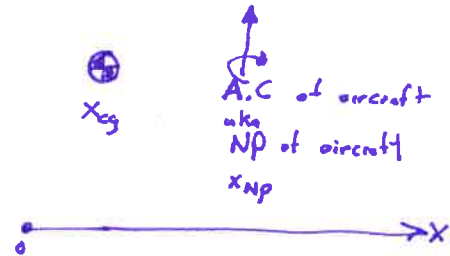

$X_{cg} = 0.25 \, \bar{c}$

$S = 180 \, ft^2$

$W = 2750 \, lbf$

From above

• $\dfrac{dC_m}{dC_L} \approx \dfrac{\Delta C_m}{\Delta C_L}\bigg|_{\delta_e \, curve} = \dfrac{0.15 - 0}{0 - 1.0} = -0.15$ ▧ no units

• $\dfrac{dC_m}{d\delta_e} = \dfrac{\Delta C_m}{\Delta \delta_e}\bigg|_{C_L = 0} = \dfrac{0.15 - 0}{-15° - 5°} = \dfrac{0.15}{20°} = 0.0075 \, \frac{1}{deg}$

a) NP_{sf}

$$\dfrac{dC_m}{dC_L} = \left(\dfrac{X_{cg}}{\bar{c}} - \dfrac{X_{NP}}{\bar{c}} \right) \implies \dfrac{X_{NP}}{\bar{c}} = \dfrac{X_{cg}}{\bar{c}} - \dfrac{dC_m}{dC_L}$$

$$= 0.25 - (-0.15)$$

$$\boxed{\dfrac{X_{NP}}{\bar{c}} = 0.40}$$

b) Fly at $125 \, ft/s$

$$qS C_L = W \implies C_L = \dfrac{W}{qS} = \dfrac{2W}{\rho V^2 S}$$

$$= \dfrac{2}{1} \left| \dfrac{2750 \, lbf}{1} \right| \dfrac{ft^3}{0.002375 \, lbs} \left| \dfrac{s^2}{125^2 \, ft^2} \right| \dfrac{1}{180 \, ft^2} \left| \dfrac{slug \, ft}{lbf \, s^2} \right.$$

$$= 0.825$$

we need $C_m = 0$ at $C_L = 0.825$

$$C_m = C_{m_0} + C_{m_{C_L}} C_L + C_{m_{\delta_e}} \delta_e = 0$$

$$\underset{\downarrow}{0.15 - 0.0075 \cdot 15°}$$

$$0.0375 + -0.15 \cdot .825 + 0.0075 \cdot \delta_e \implies \boxed{\delta_e = 11.5°}$$