7) i) No momento de arfagem vamos incluir $C_{m_{ac_t}}$.

Assumiremos $C_{m_{ac_{wb}}} = C_{m_{ac_w}} = C_{m_{ac_t}}$

De 2.3.22a

$$C_{m_{ac_{wb}}} = C_{m_{ac_w}} + C_{m_{ac_t}} = 2C_{m_{ac_w}} \qquad \mathrm{I}$$

e ainda

$$a_t = a_w = a_{wb} \qquad \mathrm{II}$$

$$h_{n_{wb}} = h_{n_w} \qquad \mathrm{III}$$

$$S_t = S \qquad \mathrm{IV}$$

De 2.3.18

$$a = \frac{\partial C_L}{\partial \alpha} = a_{wb}\left[1 + \frac{a_t}{a_{wb}}\frac{S_t}{S}\left(1 - \frac{\partial \varepsilon}{\partial \alpha}\right)\right]$$

$$a = a_w\left[2 - \frac{\partial \varepsilon}{\partial \alpha}\right]$$ (v)

De 2.3.21a, ignorando efeitos propulsivos

$$C_{m_\alpha} = a\left(h - h_{n_{wb}}\right) - a_t \bar{V}_H\left(1 - \frac{\partial \varepsilon}{\partial \alpha}\right)$$

$$C_{m\alpha} = a(h - h_{nw}) - \frac{a_w \bar{l}_t}{\bar{c}}\left(1 - \frac{\partial\varepsilon}{\partial\alpha}\right) \qquad (VI)$$

De 2.3.22a com $C_{m_{ac_{wb}}} = 2C_{m_{ac_w}}$ e ignorando efeitos propulsivos

$$C_{m_0} = 2C_{m_{ac_w}} + a_t \bar{V}_H(\varepsilon_0 + i_t)\left[1 - \frac{a_t}{a}\frac{S_t}{S}\left(1 - \frac{\partial\varepsilon}{\partial\alpha}\right)\right]$$

$$C_{m_0} = 2C_{m_{ac_w}} + \frac{a_w \bar{l}_t}{\bar{c}}(\varepsilon_0 + i_t)\left[1 - \frac{a_w}{a}\left(1 - \frac{\partial\varepsilon}{\partial\alpha}\right)\right] \qquad (VII)$$

Substituindo V em VII

$$C_{m_0} = 2C_{mac_w} + \frac{a_w \bar{l}_t}{\bar{c}}(\varepsilon_0 + i_t) \frac{1}{\left(2 - \frac{\partial \varepsilon}{\partial \alpha}\right)} \quad \text{VIII}$$

ii) De 2.3.23 ignorando efeitos propulsivos

$$h_n = h_{n_{wb}} + \frac{a_t}{a} \bar{V}_H \left(1 - \frac{\partial \varepsilon}{\partial \alpha}\right) \quad \text{IX}$$

Usando V, II e IV em IX

$$h_n = h_{n_{wb}} + \frac{\frac{\bar{l}_t}{\bar{c}}\left(1 - \frac{\partial \varepsilon}{\partial \alpha}\right)}{\left(2 - \frac{\partial \varepsilon}{\partial \alpha}\right)}$$

X

Para o ponto neutro a manche fixo entre CA_{wb} e CA_t (ver fig. 2.12)

$$\bar{c}\, h_n - \bar{c}\, h_{n_{wb}} = \frac{\bar{l}_t}{2}$$

$$h_n - h_{n_{wb}} = \frac{\bar{l}_t}{2\bar{c}} \qquad \text{XI}$$

Substituindo XI em X

$$\frac{\bar{l}_t}{2\bar{c}} = \frac{\left(1 - \frac{\partial \varepsilon}{\partial \alpha}\right)}{\left(2 - \frac{\partial \varepsilon}{\partial \alpha}\right)} \frac{\bar{l}_t}{\bar{c}}$$

$\Rightarrow \frac{\partial \varepsilon}{\partial \alpha} = 0 \Rightarrow$ não é muito provável

iii) Temos

$$L_w = a_w \frac{1}{2}\rho V^2 S \alpha_w \qquad \text{XIII}$$

$$L_t = a_w \frac{1}{2}\rho V^2 S \alpha_t \qquad \text{XIV}$$

Dessa forma:

$$\frac{L_w}{L_t} = \frac{\alpha_w}{\alpha_t} \qquad \text{XV}$$

De 2.3.12

$$\alpha_t = \alpha_{wb} - i_t - \varepsilon$$

$$\alpha_t = \alpha_w - i_t - \varepsilon \qquad \text{XVI}$$

Substituindo XVI em XV

$$\frac{L_w}{L_t} = \frac{\alpha_w}{\alpha_w - i_t - \varepsilon} \qquad \text{XVII}$$

De 2.3.14

$$\varepsilon = \varepsilon_0 + \frac{d\varepsilon}{d\alpha}\alpha_{wb} \Rightarrow \varepsilon = 0{,}2\alpha_w \qquad \text{XVIII}$$

XVIII em XVII

$$\frac{L_w}{L_t} = \frac{\alpha_w}{0{,}8\alpha_w - i_t}$$

XIX

D_e 2.3.25b

$$C_m = C_{m_0} + a\alpha(h - h_n)$$

XX

Como $C_m = 0$

$\alpha = 0{,}133$ rad

XXI

De 2.3.19

$$\alpha = \alpha_{wb} - \frac{a_t}{a} \frac{S_t}{S}\left(i_t + \varepsilon_0\right)$$

XXII

Come $\alpha_w = \alpha_{wb}$

$$\alpha = 0{,}133 + \frac{a_w}{a} i_t$$

XXIII

De V

$$\frac{a_w}{a} = \frac{1}{\left(2 - \frac{2\varepsilon}{2\alpha}\right)} = 0{,}556$$

XXIV

XXIV em XXIII

$\alpha_w = 0{,}133 + 0{,}556\, i_t$

XXV em XIX

$$\frac{L_w}{L_t} = \frac{0{,}133 + 0{,}556\, i_t}{0{,}133 - 0{,}555\, i_t}$$

XXV

XXVI

8) i) Temos

$$C_L = \frac{L}{\frac{1}{2}\rho V^2 S}$$

$$C_L = \frac{L}{\frac{1}{2}\rho_0 V_E^2 S}$$

Em voo nivelado $L = W$

$$C_L = \frac{W}{\frac{1}{2}\rho_0 V_E^2 S}$$

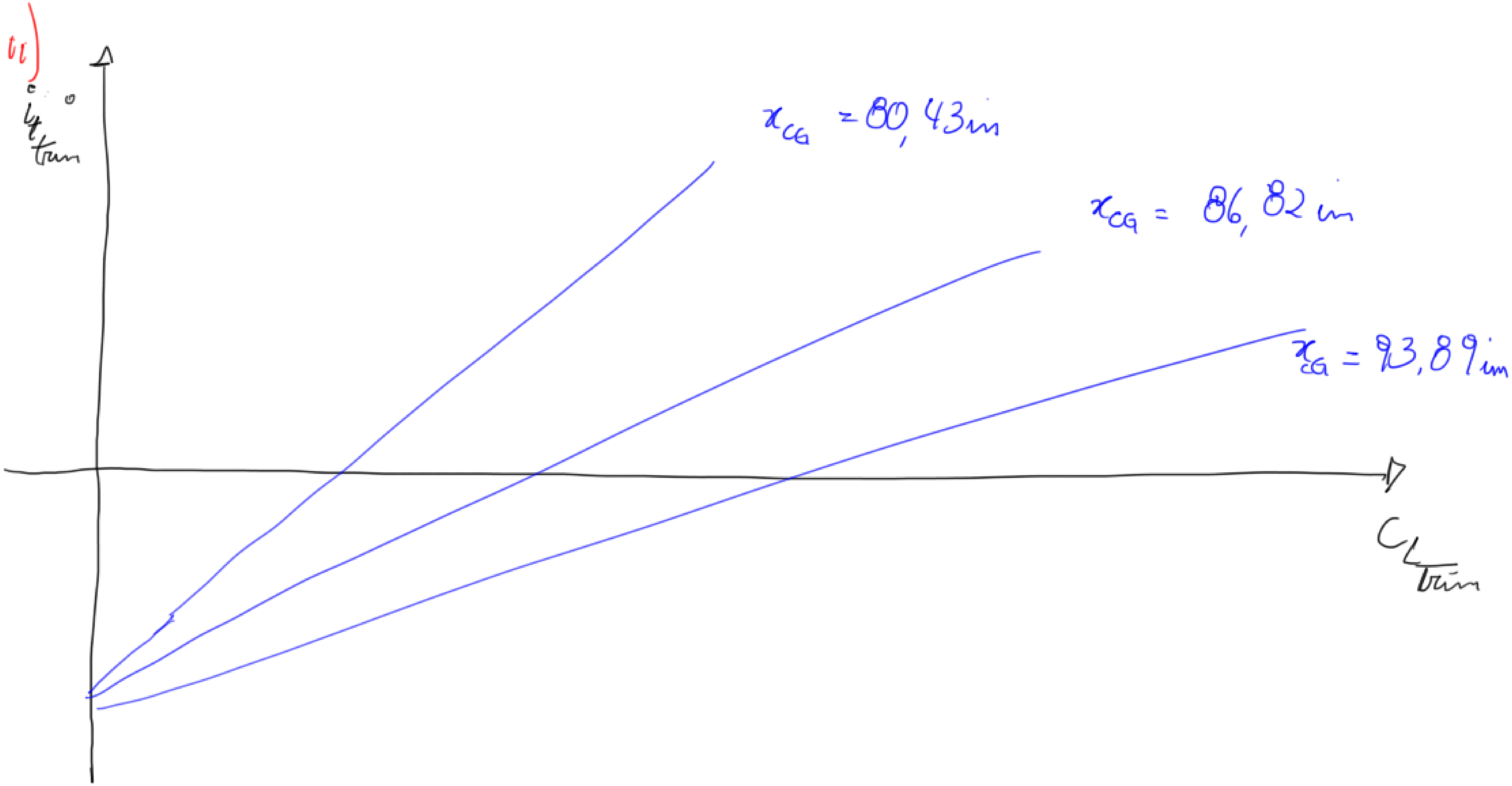
Usando o apêndice D, $\rho_0 = 2{,}3769 \cdot 10^{-3}$ slug/ft^3

$V_E(mph) \times 1{,}464 = V_E(fps)$

$S = 174{,}4 \ ft^2$

Construir

x_{cg} (in)	alt. (ft)	V_E (fps)	W (lb)	$C_{L_{trim}}$	$i_{t_{trim}}$ (deg)



ii)
i_t trim
x_CG = 80,43 in
x_CG = 86,82 in
x_CG = 93,89 in
C_L trim

iii) De 2.4.29

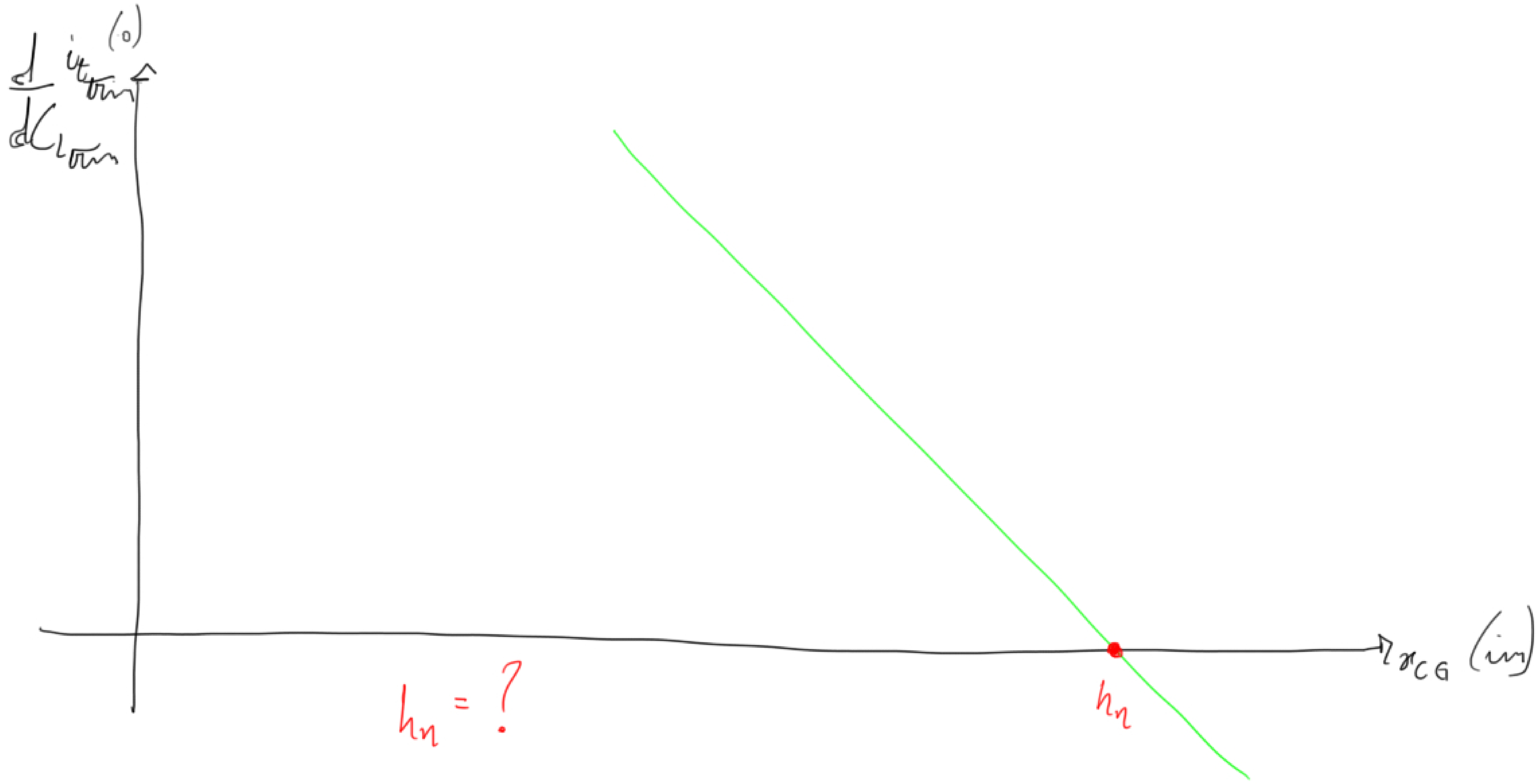
$$\frac{d\,\delta_{e_{trim}}}{dC_{L_{trim}}} = \frac{-C_{L_\alpha}}{\det}\,(h - h_n)$$

a localização do ponto neutro está em

$$\frac{d\,\delta_{e_{trim}}}{dC_{L_{trim}}} = \frac{d\,i_{t_{trim}}}{dC_{L_{trim}}} = 0$$

Construir

x_{CG} (in)	$\frac{d\,i_{t_{trim}}}{dC_{L_{trim}}}$ (°)
⋮	⋮



$\frac{d\, i_{t_{trim}}}{dC_{L_{trim}}}$ (°)
x_{CG} (in)
$h_n = ?$
h_n

10) Da 2.8.9

$$\Phi = A + B \frac{1}{2}\rho V^2 \qquad \text{I}$$

sendo

$$A = -G S_e \bar{c}_e w \frac{\alpha'}{dt} b_2 (h - h_n') \qquad \text{II}$$

$$B = G S_e \bar{c}_e \left[b_3 \delta_t + C_{he_0} + \frac{C_{m_0}}{dt} \left(C_{he_\alpha} C_{\delta e} - b_2 C_{L_\alpha} \right) \right] \qquad \text{III}$$

De 26.6

$$a' = a\left(1 - \frac{C_{l_{\delta e}}\, b_1}{a b_2}\right) \qquad \text{IV}$$

De 2.4.14a

$$\det = a\left[C_{l_{\delta e}}\left(h - h_{n_{wb}}\right) - a_e \bar{V}_H\right] \qquad \text{V}$$

Para $C_{l_{\delta e}} = 0$ em IV e V

$$a' = a \qquad \text{VI}$$

$$\det = a\left(-a_e \bar{V}_H\right) \qquad \text{VII}$$

VI em VII

$$\frac{a'}{dt} = -\frac{1}{a_e \bar{V}_H}$$

VIII

VIII em II

IX

$$A = G\, S_e \bar{c}_e\, w \left(\frac{1}{a_e \bar{V}_H}\right) b_2 \left(h - h_n'\right)$$

G em rad/ft

$G = 3°/in = 0{,}628\ rad/ft$ X

$A = 62{,}8\ lbf$ XI

XI em I

$P = A + \frac{B_f}{2} V^2$ XII

Com um sistema $V_1 = 300\ Kts = 506\ fps$

$V_2 = 310\ Kt = 522{,}9\ fps$

$$\begin{cases} 0 = A + \dfrac{B\rho}{2} V_1^2 \\ P = A + \dfrac{B\rho}{2} V_2^2 \end{cases} \tag{XIII}$$

Logo

$$\boxed{P = A - A\left(\frac{V_2}{V_1}\right)^2} \tag{XIV}$$

$$P = -4{,}26\ lbf = -18{,}94\ N$$