Practice Quiz

1. Glider aircraft, $V_H = \frac{S_H l_H}{S_W \cdot c}$ given

givens are:

S_W given

S_H given

$\eta_H = 1.0$

fuselage contribution negligable = $\frac{dC_m}{dC_L}_{fuselage} = 0$

effect of wing downwash negligable = $\frac{d\varepsilon}{d\alpha} = 0$

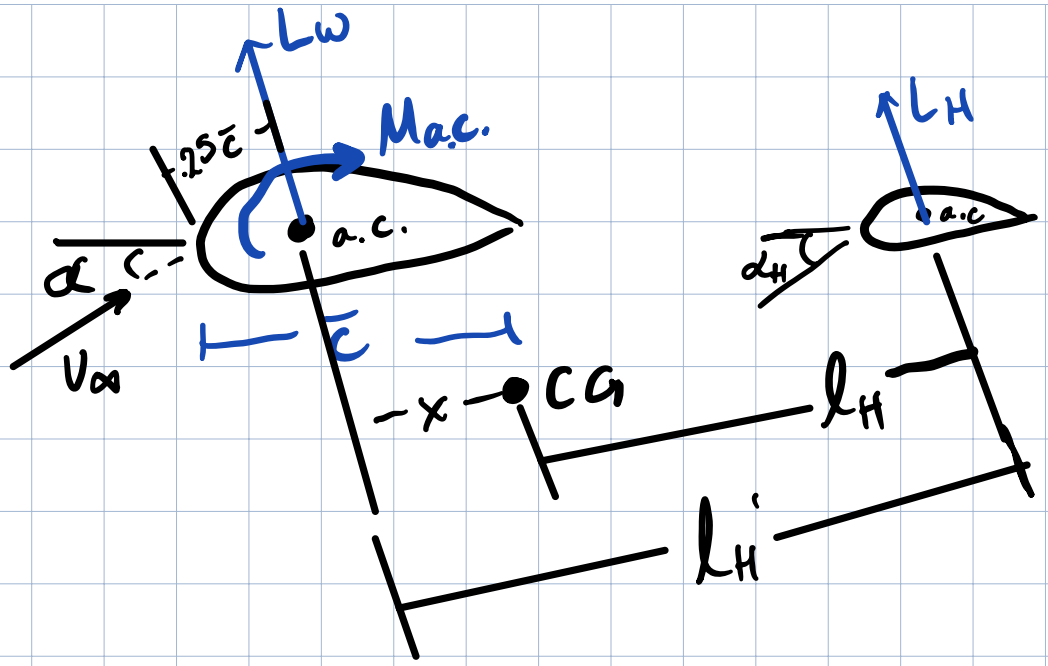
from given $C_L(\alpha)$ curves of <u>wing</u> & <u>tail</u>

Wing: $C_{L_W} = \underbrace{0.1082}_{dC_L/d\alpha_W} \cdot \alpha + 0.2199$

tail: $C_{L_H} = \underbrace{0.1108}_{dC_L/d\alpha_H} \cdot \alpha + 0$ ← Why? symetric

α ↓ degrees

find Neutral Point from LE of wing in % chord if Aerodynamic center is @ 26% chord.



Assuming fuselage contribution is small

$$\frac{dC_m}{dC_L} = \frac{x}{\bar{c}} - \left[\frac{(dC_L/d\alpha)_H}{(dC_L/d\alpha)_W}\left(1-\frac{d\varepsilon}{d\alpha}\right)\frac{S_H}{S_W}\cdot\frac{l_H'}{\bar{c}}\,\eta_H - \left(\frac{dC_m}{dC_L}\right)_F\right]$$

$$\cdot\left[\frac{1}{1+\frac{(dC_L/d\alpha)_H}{(dC_L/d\alpha)_W}\left(1-\frac{d\varepsilon}{d\alpha}\right)\frac{S_H}{S_W}\cdot\eta_H}\right]$$

@ Neutral pt, $dC_M/dC_L = 0$

then $$\frac{x}{\bar{c}} = \frac{dC_L/d\alpha_H}{dC_L/d\alpha_W}\cdot V_H\cdot\left[\frac{1}{1+\frac{dC_L/d\alpha_H}{dC_L/d\alpha_W}\cdot\frac{S_H}{S_W}}\right]$$

final answer = $\underset{ac}{26\%} + \frac{x}{\bar{c}}\cdot 100\%$

2. $h_f = 14.3 \times 10^6$ ft-lb/lb (energy/wt fuel)

$L/D = 15$

$\eta_{TH} = 0.45$

Range $= 3000$ nmi $\times$ 6076.12 $= 18230$ ft

givens: W_{fuel}/W_{total}

V_0

W_{total}

What Ve is needed?

Recall $R = h_f \cdot \eta_0 \cdot L/D \cdot \ln\left(\frac{W_0}{W_i}\right)$

& $\eta_0 = \eta_{th} \cdot \eta_{propulsive}$

& $\eta_{propulsive} = \frac{2}{Ve/V_0 + 1}$

so $\eta_{propulsive} = \frac{R}{h_f \cdot \eta_{th} \cdot \frac{L}{D} \cdot \ln\left(\frac{W_{total}}{W_{total}\left(1 - \frac{W_{fuel}}{W_{total}}\right)}\right)}$

& $Ve = V_0 \cdot \left(\frac{2}{\eta_{propulsive}} - 1\right)$

3. Quad propeller aircraft

$\rho_{SLS} = 0.00238 \ slug/ft^3$

givens: V_0 [knots] → convert to ft/s
Drag (total)
diameter of propellers = d

Assume actuator disk

then, $\text{Thrust} = \frac{\text{Drag}}{4} = 2\rho V_0^2 A(1+a)a$

Quad engine

$A = \frac{\pi}{4}d^2$

so $-\frac{(\text{Drag}/4)}{2\rho V_0^2 A} + a + a^2 = 0$

solve for a w/ quadratic formula:

$$a = \frac{-1 \pm \sqrt{1^2 - 4\cdot\left(\frac{-D/4}{2\rho V_0^2 A}\right)(1)}}{2\cdot(1)}$$

ideal efficiency $\eta = \frac{1}{1+a}$