

Problem 2.17 is optional, and will count as extra credit. Be careful of units in these problems.

1. Problem 2.1 on page 85 of Nelson
2. Problem 2.2
3. Problem 2.3
4. Problem 2.12
6. Problem 2.16
7. Problem 2.17

Hints:

- In problem 2.1 note that C_m is a linear function of C_L . You are given C_{m_o} and the slope, so solve for C_L when $C_m = 0$. The second part follows directly by using the fact that $C_{m_\alpha} = a(\frac{x_{cg}}{\bar{c}} - \frac{x_{np}}{\bar{c}})$ (see class notes), where $a = C_{L_\alpha}$ and $dC_L = a d\alpha$. (ans: $\frac{x_{np}}{\bar{c}} = 0.45$)
- In problem 2.2 use the same expression you got for $\frac{dC_m}{dC_L}$ and solve for $\frac{x_{np}}{\bar{c}}$ (ans: $\frac{x_{np}}{\bar{c}} = 0.4$). Use the fact that $C_L = W / QS$ and $C_{m_{cg}} = 0$ in trim flight to solve part b) (ans: $\delta_e = -10.5^\circ$)
- In problem 2.3, answer for part b) is $\frac{x_{np}}{\bar{c}_w} = \frac{l_t}{\bar{c}_w(1 + \frac{S_c}{S_w})}$. Use the fact that lift curve slopes of the wing and canard are equal because the aspect ratio of the airfoil sections are the same.
- In problem 2.12 you need to be able to trim at the max lift coefficient. Use the solution for the neutral point given above. Note from Fig. P2.2 that $C_{m_{cg}} = C_{m_o} + \frac{dC_m}{dC_L} C_L + C_{m_{\delta_e}} \delta_e$. You can estimate C_{m_o} from the figure by setting

$C_L = \delta_e = 0$. Solve for $\frac{dC_m}{dC_L}$ needed to trim at the max lift coefficient. Then solve for

x_{cg} needed to produce the required $\frac{dC_m}{dC_L}$ using $\frac{dC_m}{dC_L} = \frac{x_{cg}}{\bar{c}} - \frac{x_{np}}{\bar{c}}$. Note that this last expression follows directly from the last part of the hint for problem 2.1.

- In problem 2.16, first determine the C_n needed to trim the yaw moment caused by the loss of the right engine. Then determine the value of $C_{n\delta_r}$ need to achieve this value at max rudder deflection. Compute the vertical tail volume ratio. Use the expression on page 57 to estimate $C_{L\alpha_v}$ and use (2.86) to compute the factor τ . Finally, use Fig. 2.21 to estimate the rudder reference area. (Ans: $S_r = 26.4 \text{ ft}^2$)