

## Bonus #7

Ali BaniAsad 96108378

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Delta elevator equation:

$$\delta_{E_1} = \frac{-C_{L_\alpha}(C_{m_0} + C_{m_{i_H}} i_H) - C_{m_\alpha}(C_L - C_{L_0} - C_{L_{i_H}} i_H)}{C_{L_\alpha} C_{m_{\delta_E}} - C_{m_\alpha} C_{l_{\delta_E}}}$$

For above equation we can assume every parameter is constant except  $\bar{x}_{cg}$ , there is one equation and one unknowns. I use this assumptions to simplify equations and solved with MATLAB and code has attached.

$$C_{m_\alpha} = C_{L_{\alpha_{wb}}}(\bar{x}_{cg} - \bar{x}_{ac_{wb}}) - H(\bar{x}_{ac_H} - \bar{x}_{cg})$$

$$C_{m_{i_h}} = -IH(\bar{x}_{ac_H} - \bar{x}_{cg})$$

$$C_{m_{\delta_E}} = -\Delta E(\bar{x}_{ac_H} - \bar{x}_{cg})$$

Above equation solved symbolic with MATLAB and for positive and negative  $\delta_E$  we must have two  $x_{cg}$ . With this method we can find out locations of  $c_{cg}$  that we can control aircraft.