Elevator displacement curves

In the diagrams, the green lines are stable ($C_{M_\alpha} < 0$), the blue lines are neutrally stable ($C_{M_\alpha} = 0$) and the red lines are instable ($C_{M_\alpha} > 0$). The curves in the diagrams were drawn with $C_{M_0} > 0$ and $C_{M_{\delta_e}} < 0$.

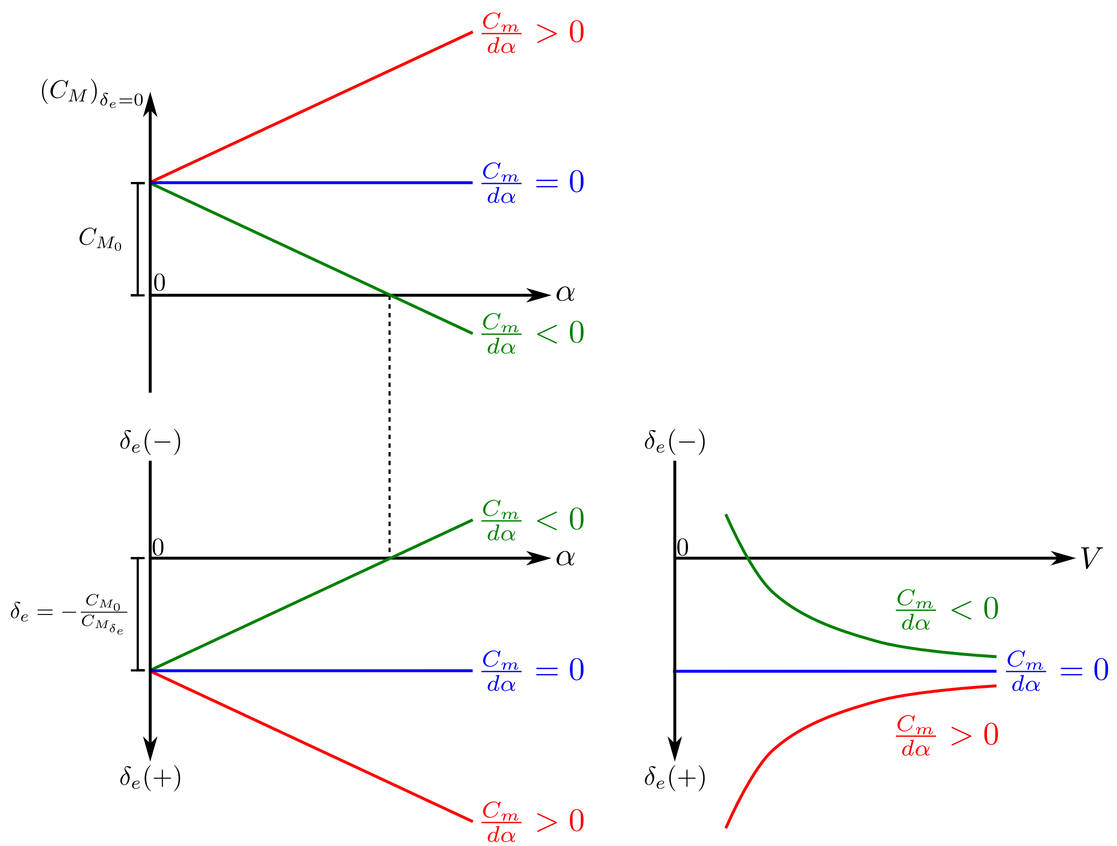


Figure 1: The elevator displacement curves.

Elevator control force curve

An aircraft has elevator stick force stability if: $\left(\frac{dF_e}{V}\right)_{F_e=0} > 0$. In the diagrams, the green lines are stick force stable, the blue lines are neutrally stable and the red lines are instable.

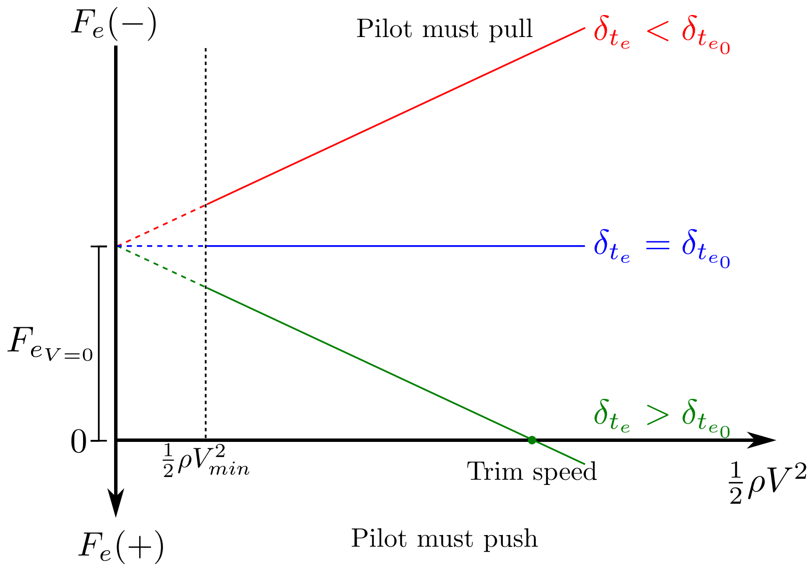


Figure 2: The elevator control force versus the dynamic pressure. Note that negative forces (pull forces for the pilot) are directed upwards in the figure.

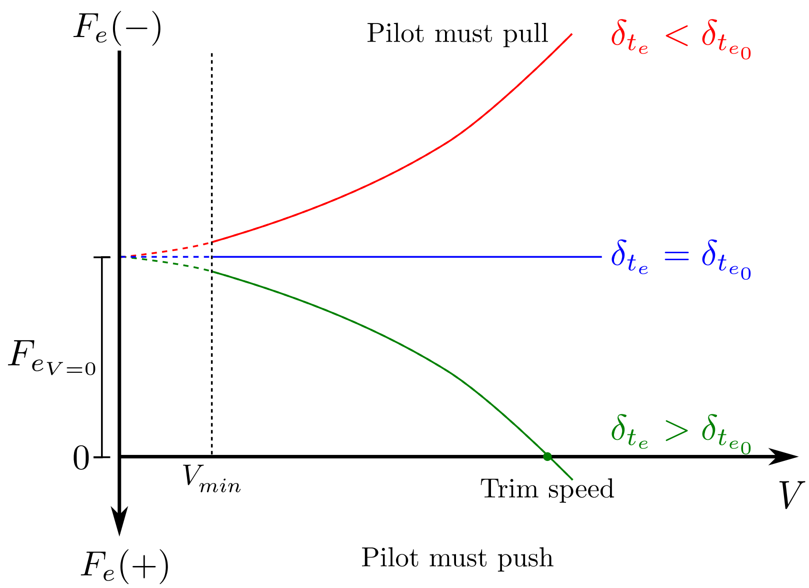
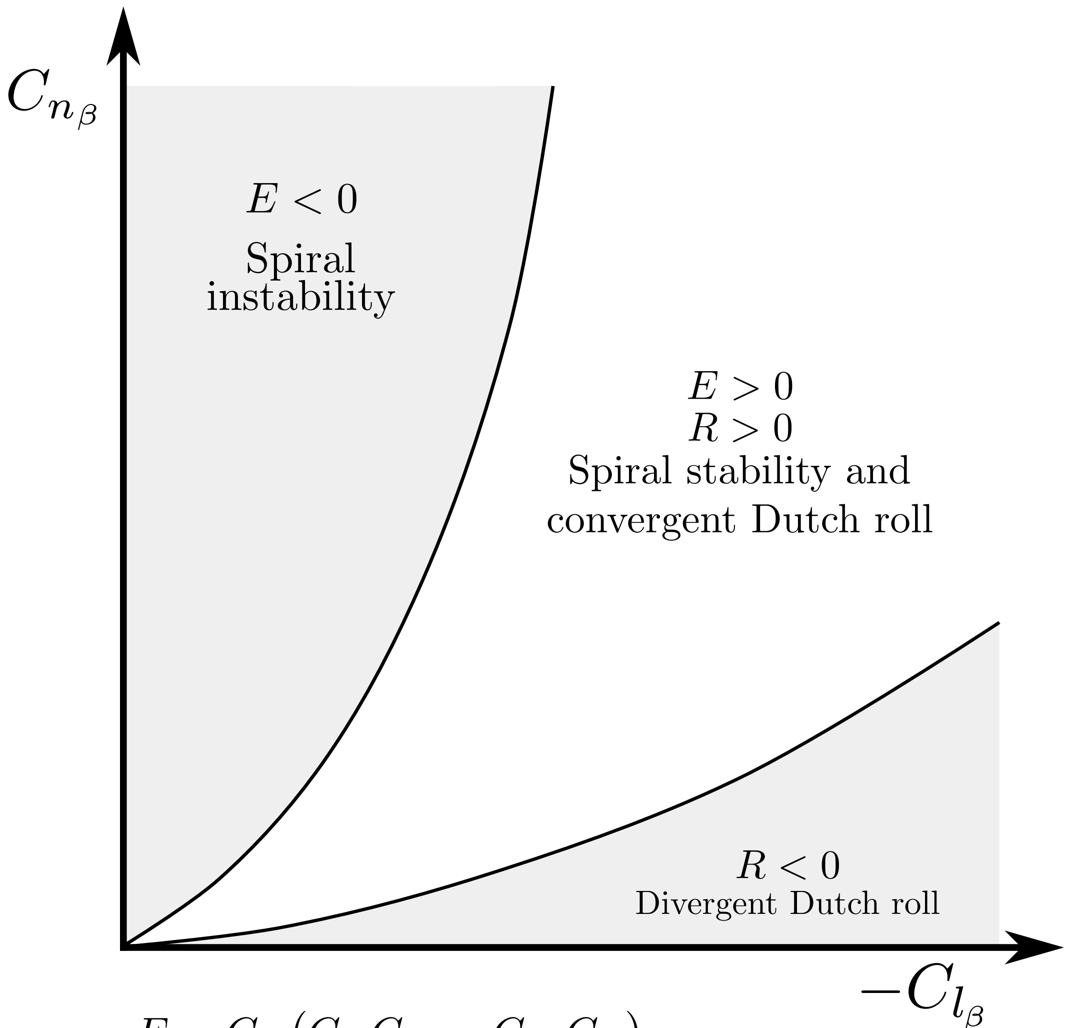


Figure 3: The elevator control force versus the airspeed.

Lateral stability diagram

For pleasant control characteristics, it always holds that: $C_{n_\beta} > 0$ and $C_{l_\beta} < 0$.



$$E = C_L\left(C_{l_\beta} C_{n_r} - C_{n_\beta} C_{l_r}\right)$$

$$R = BCD - AD^2 - BE$$

(From the characteristic equation: $A\lambda_c^4 + B\lambda_c^3 + C\lambda_c^2 + D\lambda_c + E = 0$)

Figure 4: The lateral stability diagram.

Metacenters, neutral line, neutral point and the aerodynamic center

The figure below shows the construction of the two metacenters, the neutral line, the neutral point and the aerodynamic center (AC).

In practice, the AC is very close to the M.A.C. Assuming that that the AC is on the M.A.C. means it will coincide with the neutral point. This assumes that the contribution of the tangential force on the moment can be neglected.

Refer to paragraph 8.1 (page 242) of the reader for more information.

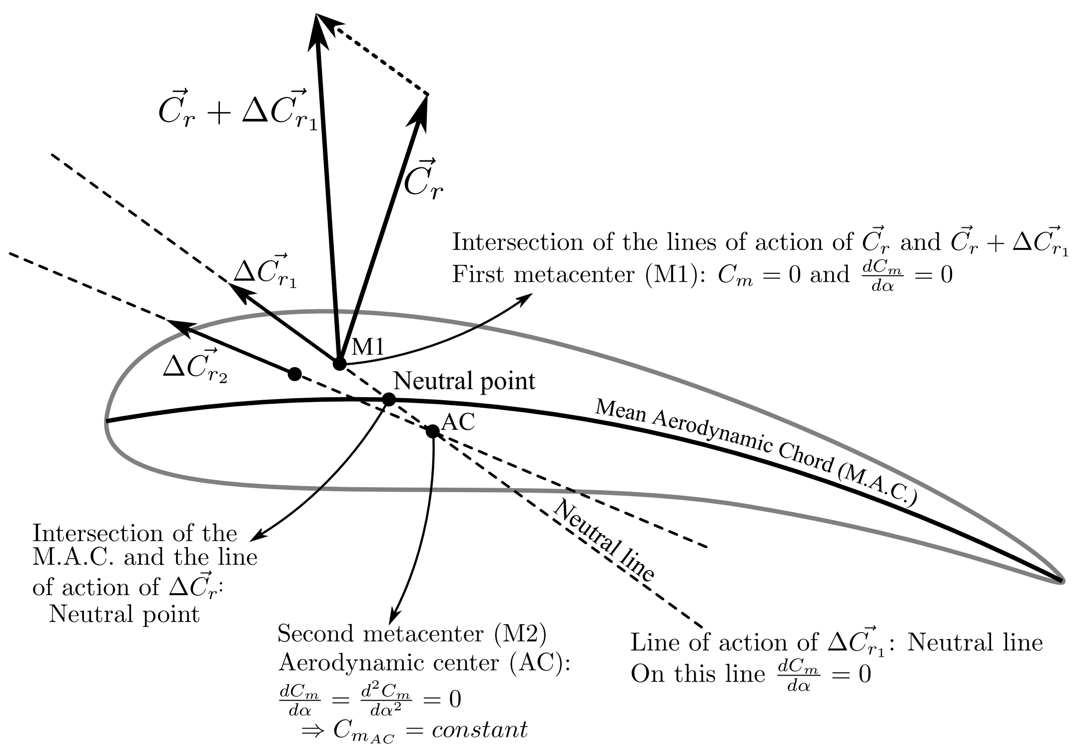


Figure 5: Construction the positions of the AC, the neutral line and the neutral point. The forces $\vec{C_r}$ and $\vec{C_r} + \Delta\vec{C_{r_1}}$ are the resultant forces of two adjecent angles of attack. $\Delta\vec{C_{r_1}}$ is the change in resultant force between them. $\Delta\vec{C_{r_2}}$ is the change between two resultant force vectors at a different angle of attack.