Module-7

Lecture-31

Flight Experiment: Flight tests to estimate stick free and fixed, neutral and maneuvering points

Flight test to estimate stick-fixed neutral point

Step 1: Cruise the aircraft at different speed.

Step 2: Note down the δe required for each trim.

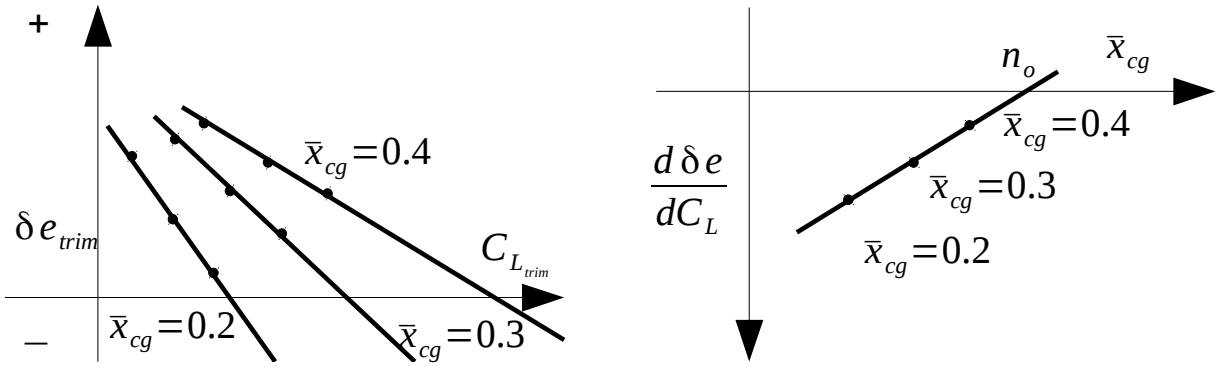
Step 3: Using the following equation:

$$\frac{d\delta e}{dC_L} = \frac{-\frac{dC_m}{dC_L}}{C_{m_{\delta e}}} = \frac{\bar{n}_o - \bar{x}_{cg}}{C_{m_{\delta e}}}$$

Plot $(\delta e)_{trim}$ vs $C_{L_{trim}}$ for various $\bar{x}_{cg}$ locations.

Step 4: Plot $d\delta e/dC_L$ vs $\bar{x}_{cg}$

Step 5: Extrapolate to get $\bar{n}_o$ ($\bar{x}_{cg}$) at which $d\delta e/dC_L = 0$



Record chart: Neutral Point (Stick Fixed)

V	δe	Altitude	OAT	$\bar{x}_{cg}$	Weight: Initial	Weight: Final
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

Flight test to estimate stick-free neutral point

Step 1: Cruise the aircraft at different speed.

Step 2: Note down the stick force F_s required for each trim.

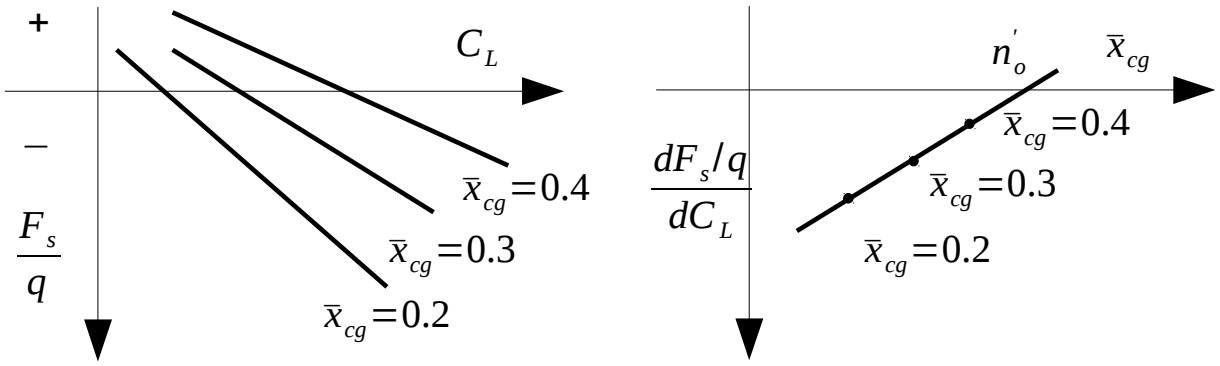
Step 3: Using equation:

$$\frac{\frac{dF_s}{q}}{dC_L} \propto \left[\frac{dC_m}{dC_L}\right]_{free} = \left[\bar{x}_{cg} - \bar{n}_o^{'}\right]$$

Plot F_s/q vs C_L for various $\bar{x}_{cg}$ locations.

Step 4: Plot $(dF_s/q)/dC_L$ vs $\bar{x}_{cg}$

Step 5: Extrapolate to get $\bar{n}_o^{'}$ $(\bar{x}_{cg})$ at which $(dF_s/q)/dC_L$



Record chart: Neutral Point (Stick Free)

V	F_s	Altitude	OAT	$\bar{x}_{cg}$	Weight: Initial	Weight: Final
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

Flight test to estimate stick-fixed maneuvering point

Step 1: Steady pullup the airplane at different n (at different speed).

Step 2: Measure the elevator deflection angle δe.

Step 3: Measure V, ρ. Calculate V_{true}.

Step 4: Calculate $\bar{q}$ in V_{true}

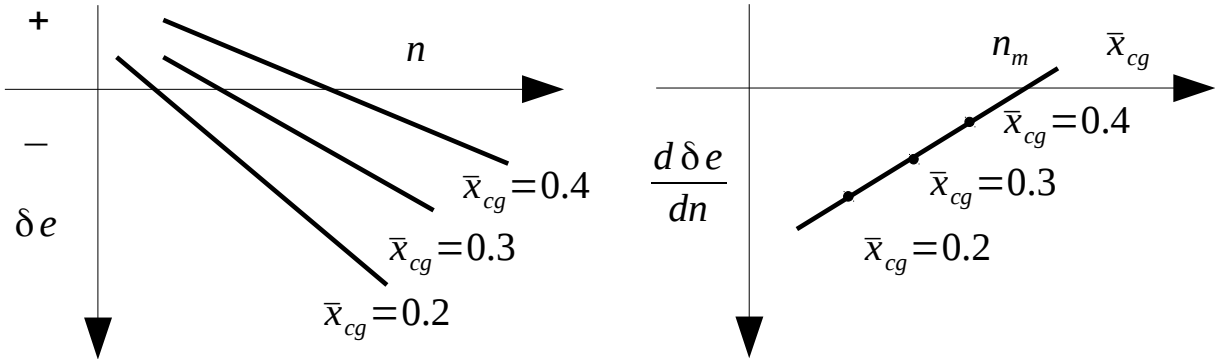
Step 5: Using the following equation:

$$\frac{d\delta e}{dn} = -\frac{W/S}{\bar{q}C_{m_{\delta e}}}\left[\bar{x}_{cg} - \bar{n}_m\right]$$

Step 6: Plot δe vs n for different $\bar{x}_{cg}$

Step 7: Plot $d\delta e/dn$ vs $\bar{x}_{cg}$

Step 8: Intercept at $\bar{x}_{cg}$-axis is stick-fixed maneuvering point.



Record chart: Maneuvering Point (Stick Fixed)

V	ϕ	δe	Altitude	OAT	$\bar{x}_{cg}$
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
V_5	-	-	-	-	-

ϕ: bank angle

Flight test to estimate stick-free maneuvering point

Step 1: Steady pullup the airplane at different n (at different speed).

Step 2: Measure the stick force.

Step 3: Measure V, ρ. Calculate V_{true}.

Step 4: Calculate $\bar{q}$ in V_{true}

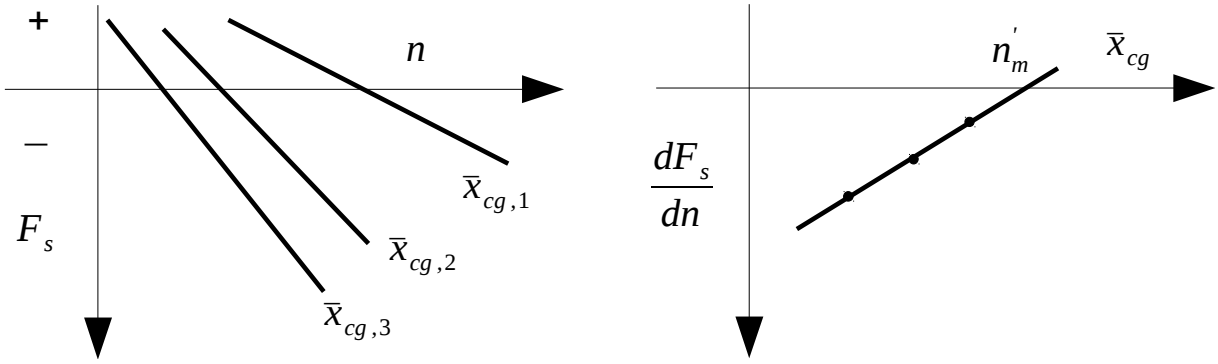
Step 5: Using the following equation:

$$\frac{dF_s}{dn} = GqS_e c_e C_{h_{\delta e}} \frac{W/S}{C_{m_{\delta_a}}} \left[\bar{x}_{cg} - \bar{n}'_m\right]$$

Step 6: Plot F_s vs n for different $\bar{x}_{cg}$.

Step 7: Plot dF_s/dn vs $\bar{x}_{cg}$.

Step 8: Intercept at $\bar{x}_{cg}$-axis is stick-free maneuvering point.



Record chart: Maneuvering Point (Stick Free)

V	F_s	ϕ	Altitude	OAT	$\bar{x}_{cg}$
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
V_5	-	-	-	-	-