Important Lateral Control Formulas PDF

Formulas
Examples
with Units

List of 10
Important Lateral Control Formulas

1) Aileron Control Effectiveness given Aileron Deflection Formula

Evaluate Formula

Formula

$$\tau = \frac{C_l}{C_{l\alpha} \cdot \delta_a}$$

Example with Units

$$0.6636 = \frac{0.073}{0.02 \cdot 5.5\,\text{rad}}$$

2) Aileron Deflection given Aileron Lift Coefficient Formula

Evaluate Formula

Formula

$$C_l = \frac{2 \cdot C_{l\alpha w} \cdot \tau \cdot \delta_a}{S \cdot b} \cdot \int \left(c \cdot x, x, y_1, y_2 \right)$$

Example with Units

$$0.0731 = \frac{2 \cdot 0.23 \cdot 0.66 \cdot 5.5\,\text{rad}}{17\,\text{m}^2 \cdot 200\,\text{m}} \cdot \int \left(2.1\,\text{m} \cdot x, x, 1.5\,\text{m}, 12\,\text{m} \right)$$

3) Aileron Section lift Coefficient given Aileron Deflection Formula

Evaluate Formula

Formula

$$C_l = C_{l\alpha} \cdot \left(\frac{d\alpha}{d\delta_a} \right) \cdot \delta_a$$

Example with Units

$$0.0733 = 0.02 \cdot \left(\frac{3.0\,\text{rad}}{4.5\,\text{rad}} \right) \cdot 5.5\,\text{rad}$$

4) Aileron Section Lift Coefficient given Control Effectiveness Formula

Evaluate Formula

Formula

$$C_l = C_{l\alpha} \cdot \tau \cdot \delta_a$$

Example with Units

$$0.0726 = 0.02 \cdot 0.66 \cdot 5.5\,\text{rad}$$

5) Deflection Angle given Lift Coefficient Formula

Evaluate Formula

Formula

$$\delta_a = \frac{C_l}{C_{l\alpha} \cdot \tau}$$

Example with Units

$$5.5303\,\text{rad} = \frac{0.073}{0.02 \cdot 0.66}$$

6) Lift Coefficient Slope Roll Control Formula

Evaluate Formula

Formula

$$C_{l\alpha} = \frac{C_l}{\delta_a \cdot \tau}$$

Example with Units

$$0.0201 = \frac{0.073}{5.5\,\text{rad} \cdot 0.66}$$

7) Lift Coefficient with respect to Roll Rate Formula

Evaluate Formula

Formula

$$Cl = -\left(\frac{2 \cdot p}{S_r \cdot b \cdot u_0}\right) \cdot \int\left(Cl_\alpha \cdot c \cdot x^2, x, 0, \frac{b}{2}\right)$$

Example with Units

$$0.038 = -\left(\frac{2 \cdot 0.5\,\text{rad/s}^2}{184\,\text{m}^2 \cdot 200\,\text{m} \cdot 50\,\text{m/s}}\right) \cdot \int\left(-0.1 \cdot 2.1\,\text{m} \cdot x^2, x, 0, \frac{200\,\text{m}}{2}\right)$$

8) Lift given Roll Rate Formula

Evaluate Formula

Formula

$$L = -2 \cdot \int\left(Cl_\alpha \cdot \left(\frac{p \cdot x}{u_0}\right) \cdot Q \cdot c \cdot x, x, 0, \frac{b}{2}\right)$$

Example with Units

$$770\,\text{N} = -2 \cdot \int\left(-0.1 \cdot \left(\frac{0.5\,\text{rad/s}^2 \cdot x}{50\,\text{m/s}}\right) \cdot 0.55\,\text{rad/s}^2 \cdot 2.1\,\text{m} \cdot x, x, 0, \frac{200\,\text{m}}{2}\right)$$

9) Roll Control Power Formula

Evaluate Formula

Formula

$$Cl_{\delta\alpha} = \frac{2 \cdot C_{l\alpha w} \cdot \tau}{S \cdot b} \cdot \int\left(c \cdot x, x, y_1, y_2\right)$$

Example with Units

$$0.0133\,\text{rad} = \frac{2 \cdot 0.23 \cdot 0.66}{17\,\text{m}^2 \cdot 200\,\text{m}} \cdot \int\left(2.1\,\text{m} \cdot x, x, 1.5\,\text{m}, 12\,\text{m}\right)$$

10) Roll Damping Coefficient Formula

Evaluate Formula

Formula

$$Cl_p = -\frac{4 \cdot C_{l\alpha w}}{S \cdot b^2} \cdot \int\left(c \cdot x^2, x, 0, \frac{b}{2}\right)$$

Example with Units

$$-0.9471 = -\frac{4 \cdot 0.23}{17\,\text{m}^2 \cdot 200\,\text{m}^2} \cdot \int\left(2.1\,\text{m} \cdot x^2, x, 0, \frac{200\,\text{m}}{2}\right)$$

Variables used in list of Lateral Control Formulas above

- **b** Wingspan *(Meter)*
- **c** Chord *(Meter)*
- C_l Lift Coefficient Roll Control
- $C_{l\alpha}$ Lift Coefficient Slope Roll Control
- $C_{l\alpha w}$ Derivative of Wing Lift Coefficient
- **Cl** Lift Coefficient with respect to Roll Rate
- Cl_p Roll Damping Coefficient
- Cl_α Lift Curve Slope
- $Cl_{\delta\alpha}$ Roll Control Power *(Radian)*
- **dα** Rate of change of Angle of Attack *(Radian)*
- $d\delta_a$ Rate of change of Deflection of Aileron *(Radian)*
- **L** Lift with respect to Roll Rate *(Newton)*
- **p** Roll Rate *(Radian per Square Second)*
- **Q** Pitch Rate *(Radian per Square Second)*
- **S** Wing Area *(Square Meter)*
- S_r Wing reference Area *(Square Meter)*
- u_0 Reference Velocity across X Axis *(Meter per Second)*
- y_1 Initial Length *(Meter)*
- y_2 Final Length *(Meter)*
- δ_a Deflection of Aileron *(Radian)*
- **τ** Flap Effectiveness Parameter

Constants, Functions, Measurements used in list of Lateral Control Formulas above

- Functions: **int**, int(expr, arg, from, to)
  The definite integral can be used to calculate net signed area, which is the area above the x -axis minus the area below the x -axis.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Radian (rad)
  Angle Unit Conversion
- Measurement: **Angular Acceleration** in Radian per Square Second (rad/s²)
  Angular Acceleration Unit Conversion

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