Important High Load Factor Maneuver Formulas PDF

Formulas
Examples
with Units

List of 17
Important High Load Factor Maneuver Formulas

1) Change in Angle of Attack due to Upward Gust Formula

Evaluate Formula

Formula

$$\Delta\alpha = \tan\left(\frac{u}{V}\right)$$

Example with Units

$$0.2397\,\text{rad} = \tan\left(\frac{8\,\text{m/s}}{34\,\text{m/s}}\right)$$

2) Lift Coefficient for given Turn Radius Formula

Evaluate Formula

Formula

$$C_L = \frac{W}{0.5 \cdot \rho_\infty \cdot S \cdot [g] \cdot R}$$

Example with Units

$$0.002 = \frac{1800\,\text{N}}{0.5 \cdot 1.225\,\text{kg/m}^3 \cdot 5.08\,\text{m}^2 \cdot 9.8066\,\text{m/s}^2 \cdot 29495.25\,\text{m}}$$

3) Lift Coefficient for given Turn Rate Formula

Evaluate Formula

Formula

$$C_L = 2 \cdot W \cdot \frac{\omega^2}{[g]^2 \cdot \rho_\infty \cdot n \cdot S}$$

Example with Units

$$0.002 = 2 \cdot 1800\,\text{N} \cdot \frac{1.144\,\text{degree/s}^2}{9.8066\,\text{m/s}^2{}^2 \cdot 1.225\,\text{kg/m}^3 \cdot 1.2 \cdot 5.08\,\text{m}^2}$$

4) Lift Coefficient for given wing loading and turn radius Formula

Evaluate Formula

Formula

$$C_L = 2 \cdot \frac{W_S}{\rho_\infty \cdot R \cdot [g]}$$

Example with Units

$$0.002 = 2 \cdot \frac{354\,\text{Pa}}{1.225\,\text{kg/m}^3 \cdot 29495.25\,\text{m} \cdot 9.8066\,\text{m/s}^2}$$

5) Load factor for given turn radius for high-performance fighter aircraft Formula

Evaluate Formula

Formula

$$n = \frac{v^2}{[g] \cdot R}$$

Example with Units

$$1.2 = \frac{589.15\,\text{m/s}^2}{9.8066\,\text{m/s}^2 \cdot 29495.25\,\text{m}}$$

6) Load factor for given turn rate for high-performance fighter aircraft Formula

Evaluate Formula

Formula

$$n = v \cdot \frac{\omega}{[g]}$$

Example with Units

$$1.1995 = 589.15\,\text{m/s} \cdot \frac{1.144\,\text{degree/s}}{9.8066\,\text{m/s}^2}$$

7) Minimum Flight Velocity Formula

Evaluate Formula

Formula

$$V_{min} = \sqrt{\left(\frac{W}{S}\right) \cdot \left(\frac{2}{\rho}\right) \cdot \left(\frac{1}{C_L}\right)}$$

Example with Units

$$589.9388\,\text{m/s} = \sqrt{\left(\frac{1800\,\text{N}}{4\,\text{m}^2}\right) \cdot \left(\frac{2}{1.293\,\text{kg/m}^3}\right) \cdot \left(\frac{1}{0.002}\right)}$$

8) Radius of Turn for given Lift Coefficient Formula

Evaluate Formula

Formula

$$R = 2 \cdot \frac{W}{\rho_\infty \cdot S \cdot [g] \cdot C_L}$$

Example with Units

$$29495.2464\,\text{m} = 2 \cdot \frac{1800\,\text{N}}{1.225\,\text{kg/m}^3 \cdot 5.08\,\text{m}^2 \cdot 9.8066\,\text{m/s}^2 \cdot 0.002}$$

9) Radius of Turn for given Wing Loading Formula

Evaluate Formula

Formula

$$R = 2 \cdot \frac{W_S}{\rho_\infty \cdot C_L \cdot [g]}$$

Example with Units

$$29467.7175\,\text{m} = 2 \cdot \frac{354\,\text{Pa}}{1.225\,\text{kg/m}^3 \cdot 0.002 \cdot 9.8066\,\text{m/s}^2}$$

10) Turn radius for high load factor Formula

Evaluate Formula

Formula

$$R = \frac{v^2}{[g] \cdot n}$$

Example with Units

$$29495.0979\,\text{m} = \frac{589.15\,\text{m/s}^2}{9.8066\,\text{m/s}^2 \cdot 1.2}$$

11) Turn Rate for given Lift Coefficient Formula

Evaluate Formula

Formula

$$\omega = [g] \cdot \left(\sqrt{\frac{S \cdot \rho_\infty \cdot C_L \cdot n}{2 \cdot W}}\right)$$

Example with Units

$$1.1445\,\text{degree/s} = 9.8066\,\text{m/s}^2 \cdot \left(\sqrt{\frac{5.08\,\text{m}^2 \cdot 1.225\,\text{kg/m}^3 \cdot 0.002 \cdot 1.2}{2 \cdot 1800\,\text{N}}}\right)$$

12) Turn Rate for given Wing Loading Formula

Evaluate Formula

Formula

$$\omega = [g] \cdot \left(\sqrt{\rho_\infty \cdot C_L \cdot \frac{n}{2 \cdot W_S}} \right)$$

Example with Units

$$1.145\,\text{degree/s} = 9.8066\,\text{m/s}^2 \cdot \left(\sqrt{1.225\,\text{kg/m}^3 \cdot 0.002 \cdot \frac{1.2}{2 \cdot 354\,\text{Pa}}} \right)$$

13) Turn Rate for High Load Factor Formula

Evaluate Formula

Formula

$$\omega = [g] \cdot \frac{n}{v}$$

Example with Units

$$1.1445\,\text{degree/s} = 9.8066\,\text{m/s}^2 \cdot \frac{1.2}{589.15\,\text{m/s}}$$

14) Velocity for given pull-up maneuver rate Formula

Evaluate Formula

Formula

$$V_{\text{pull-up}} = [g] \cdot \frac{n_{\text{pull-up}} - 1}{\omega}$$

Example with Units

$$240.1741\,\text{m/s} = 9.8066\,\text{m/s}^2 \cdot \frac{1.489 - 1}{1.144\,\text{degree/s}}$$

15) Velocity given Turn Radius for High Load Factor Formula

Evaluate Formula

Formula

$$v = \sqrt{R \cdot n \cdot [g]}$$

Example with Units

$$589.1515\,\text{m/s} = \sqrt{29495.25\,\text{m} \cdot 1.2 \cdot 9.8066\,\text{m/s}^2}$$

16) Wing Loading for given Turn Radius Formula

Evaluate Formula

Formula

$$W_S = \frac{R \cdot \rho_\infty \cdot C_L \cdot [g]}{2}$$

Example with Units

$$354.3308\,\text{Pa} = \frac{29495.25\,\text{m} \cdot 1.225\,\text{kg/m}^3 \cdot 0.002 \cdot 9.8066\,\text{m/s}^2}{2}$$

17) Wing Loading for given Turn Rate Formula

Evaluate Formula

Formula

$$W_S = \left([g]^2 \right) \cdot \rho_\infty \cdot C_L \cdot \frac{n}{2 \cdot \left(\omega^2 \right)}$$

Example with Units

$$354.6108\,\text{Pa} = \left(9.8066\,\text{m/s}^2{}^2 \right) \cdot 1.225\,\text{kg/m}^3 \cdot 0.002 \cdot \frac{1.2}{2 \cdot \left(1.144\,\text{degree/s}^2 \right)}$$

Variables used in list of High Load Factor Maneuver Formulas above

- **5** Aircraft Gross Wing Area *(Square Meter)*
- C_L Lift Coefficient
- **n** Load Factor
- $n_{pull-up}$ Pull-Up Load Factor
- **R** Turn Radius *(Meter)*
- **S** Reference Area *(Square Meter)*
- **u** Gust Velocity *(Meter per Second)*
- **v** Velocity *(Meter per Second)*
- **V** Flight Velocity *(Meter per Second)*
- V_{min} Minimum Flight Velocity *(Meter per Second)*
- $V_{pull-up}$ Pull-Up Maneuver Velocity *(Meter per Second)*
- **W** Aircraft Weight *(Newton)*
- W_S Wing Loading *(Pascal)*
- **Δα** Change in Angle of Attack *(Radian)*
- **ρ** Air Density *(Kilogram per Cubic Meter)*
- ρ_∞ Freestream Density *(Kilogram per Cubic Meter)*
- **ω** Turn Rate *(Degree per Second)*

Constants, Functions, Measurements used in list of High Load Factor Maneuver Formulas above

- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- Functions: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Functions: **tan**, tan(Angle)
  The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure 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 Velocity** in Degree per Second (degree/s)
  Angular Velocity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion

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