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Electrical Control System Modelling Formulas

Calculators! Examples! Conversions!

List of 16 Electrical Control System Modelling Formulas

Electrical Control System Modelling

Feedback Characteristics

1) Closed Loop Gain

Open Calculator

fx $$A_c = \frac{1}{\beta}$$

ex $$0.25 = \frac{1}{4}$$

2) Closed Loop Negative Feedback Gain

Open Calculator

fx $$A_f = \frac{A_o}{1 + (\beta \cdot A_o)}$$

ex $$0.249984 = \frac{4000}{1 + (4 \cdot 4000)}$$

3) Closed Loop Positive Feedback Gain

Open Calculator

fx $$A_f = \frac{A_o}{1 - (\beta \cdot A_o)}$$

ex $$-0.250016 = \frac{4000}{1 - (4 \cdot 4000)}$$

4) Transfer Function for Closed and Open Loop System

Open Calculator

fx $$G_s = \frac{C_s}{R_s}$$

ex $$0.458333 = \frac{22}{48}$$

Modelling Parameters

5) Angle of Asymptotes

Open Calculator

fx $$\phi_k = \frac{(2 \cdot (\text{modulus}(N - M) - 1) + 1) \cdot \pi}{\text{modulus}(N - M)}$$

ex $$5.834386\text{rad} = \frac{(2 \cdot (\text{modulus}(13 - 6) - 1) + 1) \cdot \pi}{\text{modulus}(13 - 6)}$$

6) Bandwidth Frequency given Damping Ratio

Open Calculator

fx $$f_b = \omega_n \cdot \left(\sqrt{1 - \left(2 \cdot \zeta^2\right)} + \sqrt{\zeta^4 - \left(4 \cdot \zeta^2\right) + 2} \right)$$

ex $$54.96966\text{Hz} = 23\text{Hz} \cdot \left(\sqrt{1 - \left(2 \cdot (0.1)^2\right)} + \sqrt{(0.1)^4 - \left(4 \cdot (0.1)^2\right) + 2} \right)$$

7) Damped Natural Frequency

Open Calculator

fx $$\omega_d = \omega_n \cdot \sqrt{1 - \zeta^2}$$

ex $$22.88471\text{Hz} = 23\text{Hz} \cdot \sqrt{1 - (0.1)^2}$$

8) Damping Ratio given Critical Damping

Open Calculator

fx $$\zeta = \frac{C}{C_c}$$

ex $$0.100334 = \frac{0.6}{5.98}$$

9) Damping Ratio given Percentage Overshoot

Open Calculator

fx $$\zeta = -\frac{\ln\left(\frac{\%_o}{100}\right)}{\sqrt{\pi^2 + \ln\left(\frac{\%_o}{100}\right)^2}}$$

ex $$0.100106 = -\frac{\ln\left(\frac{72.9}{100}\right)}{\sqrt{\pi^2 + \ln\left(\frac{72.9}{100}\right)^2}}$$

10) Damping Ratio or Damping Factor

Open Calculator

fx $$\zeta = \frac{c}{2 \cdot \sqrt{m \cdot K_{spring}}}$$

ex $$0.188147 = \frac{16}{2 \cdot \sqrt{35.45\text{kg} \cdot 51\text{N/m}}}$$

11) Gain-Bandwidth Product

Open Calculator

fx $$G.B = \text{modulus}(A_M) \cdot BW$$

ex $$56.16\text{Hz} = \text{modulus}(0.78) \cdot 72\text{b/s}$$

12) Number of Asymptotes

Open Calculator

fx $$N_a = N - M$$

ex $$7 = 13 - 6$$

13) Percentage Overshoot

Open Calculator

fx $$\%_o = 100 \cdot \left(e^{\frac{-\zeta \cdot \pi}{\sqrt{1 - \left(\zeta^2\right)}}} \right)$$

ex $$72.92476 = 100 \cdot \left(e^{\frac{-0.1 \cdot \pi}{\sqrt{1 - \left((0.1)^2\right)}}} \right)$$

14) Q-Factor

Open Calculator

fx $$Q = \frac{1}{2 \cdot \zeta}$$

ex $$5 = \frac{1}{2 \cdot 0.1}$$

15) Resonant Frequency

Open Calculator

fx $$\omega_r = \omega_n \cdot \sqrt{1 - 2 \cdot \zeta^2}$$

ex $$22.76884\text{Hz} = 23\text{Hz} \cdot \sqrt{1 - 2 \cdot (0.1)^2}$$

16) Resonant Peak

Open Calculator

fx $$M_r = \frac{1}{2 \cdot \zeta \cdot \sqrt{1 - \zeta^2}}$$

ex $$5.025189 = \frac{1}{2 \cdot 0.1 \cdot \sqrt{1 - (0.1)^2}}$$

Variables Used

- **$\%_o$** Percentage Overshoot
- **A_c** Closed-Loop Gain
- **A_f** Gain with Feedback
- **A_M** Amplifier Gain in Mid Band
- **A_o** Open Loop Gain of an OP-AMP
- **BW** Amplifier Bandwidth *(Bit Per Second)*
- **c** Damping Coefficient
- **C** Actual Damping
- **C_c** Critical Damping
- **C_s** Output of System
- **f_b** Bandwidth Frequency *(Hertz)*
- **G_s** Transfer Function
- **G.B** Gain-Bandwidth Product *(Hertz)*
- **K_{spring}** Spring Constant *(Newton per Meter)*
- **m** Mass *(Kilogram)*
- **M** Number of Zeroes
- **M_r** Resonant Peak
- **N** Number of Poles
- **N_a** Number of Asymptotes
- **Q** Q Factor
- **R_s** Input of System
- **β** Feedback Factor

- ζ Damping Ratio
- ϕ_k Angle of Asymptotes *(Radian)*
- ω_d Damped Natural Frequency *(Hertz)*
- ω_n Natural Frequency of Oscillation *(Hertz)*
- ω_r Resonant Frequency *(Hertz)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **e**, 2.71828182845904523536028747135266249
  Napier's constant
- Function: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- Function: **modulus**, modulus
  Modulus of a number is the remainder when that number is divided by another number.
- Function: **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.
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Angle** in Radian (rad)
  Angle Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Bandwidth** in Bit Per Second (b/s)
  Bandwidth Unit Conversion
- Measurement: **Stiffness Constant** in Newton per Meter (N/m)
  Stiffness Constant Unit Conversion

Check other formula lists

- **Control System Design Formulas**
- **Electrical Control System Modelling Formulas**
- **Transient and Steady State Response Formulas**

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