Important Frequency of Free Damped Vibrations Formulas PDF

Formulas
Examples
with Units

List of 19
Important Frequency of Free Damped Vibrations Formulas

1) Amplitude Reduction Factor Formula

Evaluate Formula

Formula

$$A_{reduction} = e^{a \cdot t_p}$$

Example with Units

$$1.8221 = e^{0.2\,\text{Hz} \cdot 3\,\text{s}}$$

2) Circular Damped Frequency Formula

Evaluate Formula

Formula

$$\omega_d = \sqrt{\frac{k}{m} - \left(\frac{c}{2 \cdot m}\right)^2}$$

Example with Units

$$6.9208 = \sqrt{\frac{60\,\text{N/m}}{1.25\,\text{kg}} - \left(\frac{0.8\,\text{Ns/m}}{2 \cdot 1.25\,\text{kg}}\right)^2}$$

3) Circular Damped Frequency given Natural Frequency Formula

Evaluate Formula

Formula

$$\omega_d = \sqrt{\omega_n^2 - a^2}$$

Example with Units

$$20.999 = \sqrt{21\,\text{rad/s}^2 - 0.2\,\text{Hz}^2}$$

4) Condition for Critical Damping Formula

Evaluate Formula

Formula

$$c_c = 2 \cdot m \cdot \sqrt{\frac{k}{m}}$$

Example with Units

$$17.3205\,\text{Ns/m} = 2 \cdot 1.25\,\text{kg} \cdot \sqrt{\frac{60\,\text{N/m}}{1.25\,\text{kg}}}$$

5) Critical Damping Coefficient Formula

Evaluate Formula

Formula

$$c_c = 2 \cdot m \cdot \omega_n$$

Example with Units

$$52.5\,\text{Ns/m} = 2 \cdot 1.25\,\text{kg} \cdot 21\,\text{rad/s}$$

6) Damping Factor Formula

Evaluate Formula

Formula

$$\zeta = \frac{c}{c_c}$$

Example with Units

$$0.1 = \frac{0.8\,\text{Ns/m}}{8\,\text{Ns/m}}$$

7) Damping Factor given Natural Frequency Formula

Evaluate Formula

Formula

$$\zeta = \frac{c}{2 \cdot m \cdot \omega_n}$$

Example with Units

$$0.0152 = \frac{0.8\,\text{Ns/m}}{2 \cdot 1.25\,\text{kg} \cdot 21\,\text{rad/s}}$$

8) Displacement of Mass from Mean Position Formula

Evaluate Formula

Formula

$$d_{mass} = A \cdot \cos\left(\omega_d \cdot t_p\right)$$

Example with Units

$$6.6032\,\text{mm} = 10\,\text{mm} \cdot \cos\left(6 \cdot 3\,\text{s}\right)$$

9) Frequency Constant for Damped Vibrations Formula

Evaluate Formula

Formula

$$a = \frac{c}{m}$$

Example with Units

$$0.64\,\text{Hz} = \frac{0.8\,\text{Ns/m}}{1.25\,\text{kg}}$$

10) Frequency Constant for Damped Vibrations given Circular Frequency Formula

Evaluate Formula

Formula

$$a = \sqrt{\omega_n^2 - \omega_d^2}$$

Example with Units

$$20.1246\,\text{Hz} = \sqrt{21\,\text{rad/s}^2 - 6^2}$$

11) Frequency of Damped Vibration Formula

Evaluate Formula

Formula

$$f = \frac{1}{2 \cdot \pi} \cdot \sqrt{\frac{k}{m} - \left(\frac{c}{2 \cdot m}\right)^2}$$

Example with Units

$$1.1015\,\text{Hz} = \frac{1}{2 \cdot 3.1416} \cdot \sqrt{\frac{60\,\text{N/m}}{1.25\,\text{kg}} - \left(\frac{0.8\,\text{Ns/m}}{2 \cdot 1.25\,\text{kg}}\right)^2}$$

12) Frequency of Damped Vibration using Natural Frequency Formula

Evaluate Formula

Formula

$$f = \frac{1}{2 \cdot \pi} \cdot \sqrt{\omega_n^2 - a^2}$$

Example with Units

$$3.3421\,\text{Hz} = \frac{1}{2 \cdot 3.1416} \cdot \sqrt{21\,\text{rad/s}^2 - 0.2\,\text{Hz}^2}$$

13) Frequency of Undamped Vibration Formula

Evaluate Formula

Formula

$$f = \frac{1}{2 \cdot \pi} \cdot \sqrt{\frac{k}{m}}$$

Example with Units

$$1.1027\,\text{Hz} = \frac{1}{2 \cdot 3.1416} \cdot \sqrt{\frac{60\,\text{N/m}}{1.25\,\text{kg}}}$$

14) Logarithmic Decrement Formula

Evaluate Formula

Formula

$$\delta = a \cdot t_p$$

Example with Units

$$0.6 = 0.2\,\text{Hz} \cdot 3\,\text{s}$$

15) Logarithmic Decrement using Circular Damped Frequency Formula

Evaluate Formula

Formula

$$\delta = a \cdot \frac{2 \cdot \pi}{\omega_d}$$

Example with Units

$$0.2094 = 0.2\,\text{Hz} \cdot \frac{2 \cdot 3.1416}{6}$$

16) Logarithmic Decrement using Circular Damping Coefficient Formula

Evaluate Formula

Formula

$$\delta = \frac{2 \cdot \pi \cdot c}{\sqrt{c_c^2 - c^2}}$$

Example with Units

$$0.6315 = \frac{2 \cdot 3.1416 \cdot 0.8\,\text{Ns/m}}{\sqrt{8\,\text{Ns/m}^2 - 0.8\,\text{Ns/m}^2}}$$

17) Logarithmic Decrement using Natural Frequency Formula

Evaluate Formula

Formula

$$\delta = \frac{a \cdot 2 \cdot \pi}{\sqrt{\omega_n^2 - a^2}}$$

Example with Units

$$0.0598 = \frac{0.2\,\text{Hz} \cdot 2 \cdot 3.1416}{\sqrt{21\,\text{rad/s}^2 - 0.2\,\text{Hz}^2}}$$

18) Periodic Time of Vibration Formula

Evaluate Formula

Formula

$$t_p = \frac{2 \cdot \pi}{\sqrt{\frac{k}{m} - \left(\frac{c}{2 \cdot m}\right)^2}}$$

Example with Units

$$0.9079\,\text{s} = \frac{2 \cdot 3.1416}{\sqrt{\frac{60\,\text{N/m}}{1.25\,\text{kg}} - \left(\frac{0.8\,\text{Ns/m}}{2 \cdot 1.25\,\text{kg}}\right)^2}}$$

19) Periodic Time of Vibration using Natural Frequency Formula

Evaluate Formula

Formula

$$t_p = \frac{2 \cdot \pi}{\sqrt{\omega_n^2 - a^2}}$$

Example with Units

$$0.2992\,\text{s} = \frac{2 \cdot 3.1416}{\sqrt{21\,\text{rad/s}^2 - 0.2\,\text{Hz}^2}}$$

Variables used in list of Frequency of Free Damped Vibrations Formulas above

- **a** Frequency Constant for Calculation *(Hertz)*
- **A** Amplitude of Vibration *(Millimeter)*
- $A_{reduction}$ Amplitude Reduction Factor
- **c** Damping Coefficient *(Newton Second per Meter)*
- c_c Critical Damping Coefficient *(Newton Second per Meter)*
- d_{mass} Total Displacement *(Millimeter)*
- **f** Frequency *(Hertz)*
- **k** Stiffness of Spring *(Newton per Meter)*
- **m** Mass Suspended from Spring *(Kilogram)*
- t_p Time Period *(Second)*
- **δ** Logarithmic Decrement
- **ζ** Damping Ratio
- ω_d Circular Damped Frequency
- ω_n Natural Circular Frequency *(Radian per Second)*

Constants, Functions, Measurements used in list of Frequency of Free Damped Vibrations Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- constant(s): **e**, 2.71828182845904523536028747135266249 *Napier's constant*
- Functions: **cos**, cos(Angle) *Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.*
- 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.*
- Measurement: **Length** in Millimeter (mm) *Length Unit Conversion*
- Measurement: **Weight** in Kilogram (kg) *Weight Unit Conversion*
- Measurement: **Time** in Second (s) *Time Unit Conversion*
- Measurement: **Frequency** in Hertz (Hz) *Frequency Unit Conversion*
- Measurement: **Surface Tension** in Newton per Meter (N/m) *Surface Tension Unit Conversion*
- Measurement: **Angular Velocity** in Radian per Second (rad/s) *Angular Velocity Unit Conversion*
- Measurement: **Damping Coefficient** in Newton Second per Meter (Ns/m) *Damping Coefficient Unit Conversion*

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