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Frequency of Under Damped Forced Vibrations Formulas

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List of 15 Frequency of Under Damped Forced Vibrations Formulas

Frequency of Under Damped Forced Vibrations

1) Complementary Function

Open Calculator

fx $x_1 = A \cdot \cos(\omega_d - \phi)$

ex $1.689698\text{m} = 5.25\text{m} \cdot \cos(6\text{Hz} - 55^\circ)$

2) Damping Coefficient

Open Calculator

fx $c = \dfrac{\tan(\phi) \cdot \left(k - m \cdot \omega^2\right)}{\omega}$

ex $4.998518\text{Ns/m} = \dfrac{\tan(55^\circ) \cdot \left(60\text{N/m} - .25\text{kg} \cdot (10\text{rad/s})^2\right)}{10\text{rad/s}}$

3) Deflection of System under Static Force

Open Calculator

fx $x_o = \dfrac{F_x}{k}$

ex $0.333333\text{m} = \dfrac{20\text{N}}{60\text{N/m}}$

4) External Periodic Disturbing Force

Open Calculator

fx $F = F_x \cdot \cos(\omega \cdot t_p)$

ex $16.87708\text{N} = 20\text{N} \cdot \cos(10\text{rad/s} \cdot 1.2\text{s})$

5) Maximum Displacement of Forced Vibration

Open Calculator

$$d_{max} = \frac{F_x}{\sqrt{(c \cdot \omega)^2 - \left(k - m \cdot \omega^2\right)^2}}$$

$$0.560112\text{m} = \frac{20\text{N}}{\sqrt{(5\text{Ns/m} \cdot 10\text{rad/s})^2 - \left(60\text{N/m} - .25\text{kg} \cdot (10\text{rad/s})^2\right)^2}}$$

6) Maximum Displacement of Forced Vibration at Resonance

Open Calculator

$$d_{max} = x_o \cdot \frac{k}{c \cdot \omega_n}$$

$$0.56101\text{m} = 0.3333333\text{m} \cdot \frac{60\text{N/m}}{5\text{Ns/m} \cdot 7.13\text{rad/s}}$$

7) Maximum Displacement of Forced Vibration using Natural Frequency

Open Calculator

$$d_{max} = \frac{x_o}{\sqrt{\frac{(c^2) \cdot \left(\omega^2\right)}{k^2} + \left(1 - \left(\frac{\omega^2}{\omega_n^2}\right)\right)^2}}$$

$$0.188476\text{m} = \frac{0.3333333\text{m}}{\sqrt{\frac{\left((5\text{Ns/m})^2\right) \cdot \left((10\text{rad/s})^2\right)}{(60\text{N/m})^2} + \left(1 - \left(\frac{(10\text{rad/s})^2}{(7.13\text{rad/s})^2}\right)\right)^2}}$$

8) Maximum Displacement of Forced Vibration with Negligible Damping

Open Calculator

$$d_{max} = \frac{F_x}{m \cdot \left(\omega_n^2 - \omega^2\right)}$$

$$-1.627237\text{m} = \frac{20\text{N}}{.25\text{kg} \cdot \left((7.13\text{rad/s})^2 - (10\text{rad/s})^2\right)}$$

9) Particular Integral

Open Calculator

$$x_2 = \frac{F_x \cdot \cos(\omega \cdot t_p - \phi)}{\sqrt{(c \cdot \omega)^2 - \left(k - m \cdot \omega^2\right)^2}}$$

$$0.024914\text{m} = \frac{20\text{N} \cdot \cos(10\text{rad/s} \cdot 1.2\text{s} - 55^\circ)}{\sqrt{(5\text{Ns/m} \cdot 10\text{rad/s})^2 - \left(60\text{N/m} - .25\text{kg} \cdot (10\text{rad/s})^2\right)^2}}$$

10) Phase Constant

Open Calculator

$$\phi = a\tan\left(\frac{c \cdot \omega}{k - m \cdot \omega^2}\right)$$

$$55.00798^\circ = a\tan\left(\frac{5\text{Ns/m} \cdot 10\text{rad/s}}{60\text{N/m} - .25\text{kg} \cdot (10\text{rad/s})^2}\right)$$

11) Static Force

Open Calculator

$$F_x = x_o \cdot k$$

$$20\text{N} = 0.3333333\text{m} \cdot 60\text{N/m}$$

12) Static Force using Maximum Displacement or Amplitude of Forced Vibration

Open Calculator

$$F_x = d_{max} \cdot \left(\sqrt{(c \cdot \omega)^2 - \left(k - m \cdot \omega^2\right)^2}\right)$$

$$20.03171\text{N} = 0.561\text{m} \cdot \left(\sqrt{(5\text{Ns/m} \cdot 10\text{rad/s})^2 - \left(60\text{N/m} - .25\text{kg} \cdot (10\text{rad/s})^2\right)^2}\right)$$

13) Static Force when Damping is Negligible

Open Calculator

$$F_x = d_{max} \cdot \left(m \cdot \omega_n^2 - \omega^2\right)$$

$$-48.970125\text{N} = 0.561\text{m} \cdot \left(.25\text{kg} \cdot (7.13\text{rad/s})^2 - (10\text{rad/s})^2\right)$$

14) Total Displacement of Forced Vibration given Particular Integral and Complementary Function

Open Calculator

fx $d_{tot} = x_2 + x_1$

ex $1.7\text{m} = 0.02\text{m} + 1.68\text{m}$

15) Total Displacement of Forced Vibrations

Open Calculator

fx $$d_{tot} = A \cdot \cos(\omega_d - \phi) + \frac{F_x \cdot \cos(\omega \cdot t_p - \phi)}{\sqrt{(c \cdot \omega)^2 - \left(k - m \cdot \omega^2\right)^2}}$$

ex $$1.714612\text{m} = 5.25\text{m} \cdot \cos(6\text{Hz} - 55^\circ) + \frac{20\text{N} \cdot \cos(10\text{rad/s} \cdot 1.2\text{s} - 55^\circ)}{\sqrt{(5\text{Ns/m} \cdot 10\text{rad/s})^2 - \left(60\text{N/m} - .25\text{kg} \cdot (10\text{rad/s})^2\right)^2}}$$

Variables Used

- **A** Amplitude of Vibration *(Meter)*
- **c** Damping Coefficient *(Newton Second per Meter)*
- d_{max} Maximum Displacement *(Meter)*
- d_{tot} Total Displacement *(Meter)*
- **F** External Periodic Disturbing Force *(Newton)*
- F_x Static Force *(Newton)*
- **k** Stiffness of Spring *(Newton per Meter)*
- **m** Mass suspended from Spring *(Kilogram)*
- t_p Time Period *(Second)*
- x_1 Complementary Function *(Meter)*
- x_2 Particular Integral *(Meter)*
- x_o Deflection under Static Force *(Meter)*
- ϕ Phase Constant *(Degree)*
- ω Angular Velocity *(Radian per Second)*
- ω_d Circular Damped Frequency *(Hertz)*
- ω_n Natural Circular Frequency *(Radian per Second)*

Constants, Functions, Measurements used

- Function: **atan**, atan(Number)
  Inverse tan is used to calculate the angle by applying the tangent ratio of the angle, which is the opposite side divided by the adjacent side of the right triangle.
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- 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.
- Function: **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: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle 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

Check other formula lists

- Load for Various Types of Beams and Load Conditions Formulas
- Critical or Whirling Speed of Shaft Formulas
- Effect of Inertia of Constraint in Longitudinal and Transverse Vibrations Formulas
- Frequency of Free Damped Vibrations Formulas
- Frequency of Under Damped Forced Vibrations Formulas
- Natural Frequency of Free Transverse Vibrations Formulas
- Values of length of beam for the various types of beams and under various load conditions Formulas
- Values of static deflection for the various types of beams and under various load conditions Formulas
- Vibration Isolation and Transmissibility Formulas

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