MECHANICAL VIBRATIONS

Free vibration damped system

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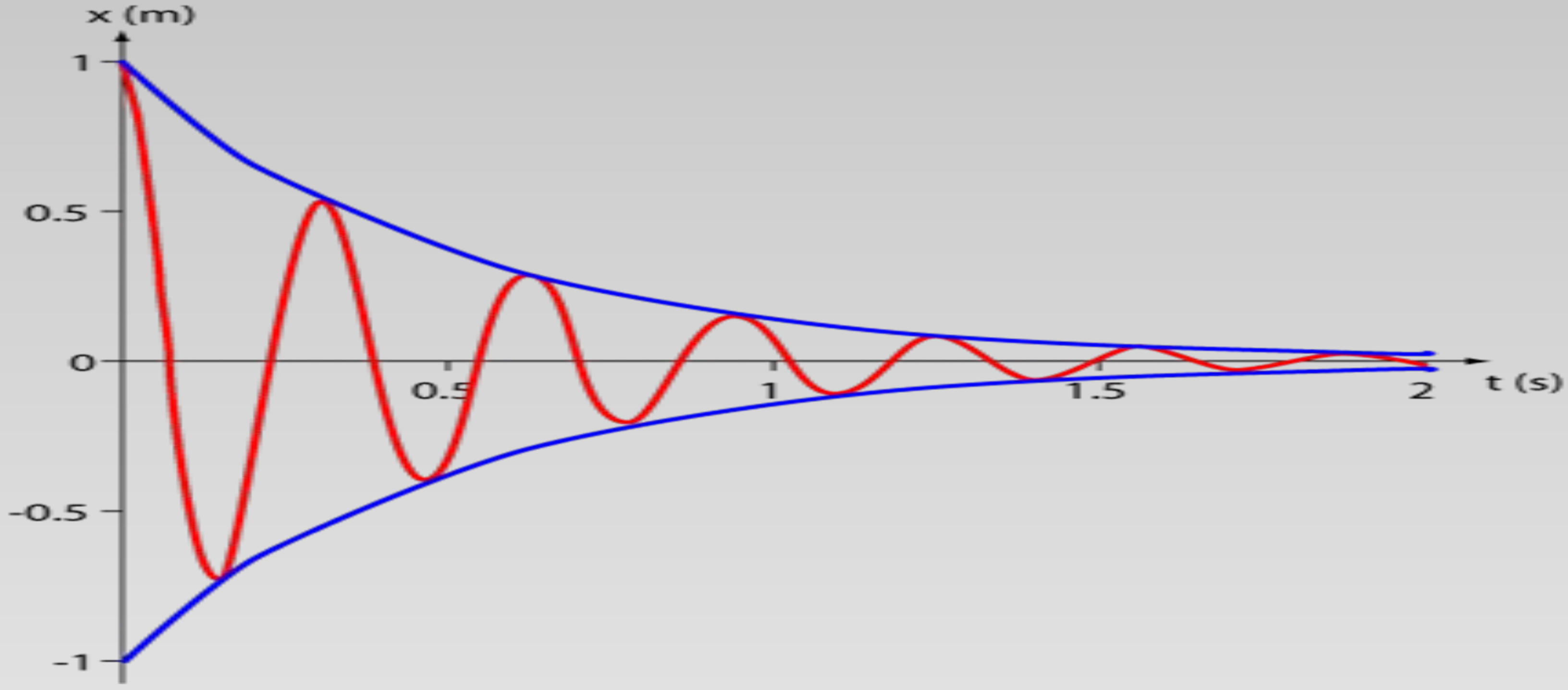
Every object, every particle and every system oscillates in its own natural frequency or set of .frequencies

Frequency mean…?? what does natural

DAMPED OSCILLATIONS

.Amplitude goes on decreasing with time

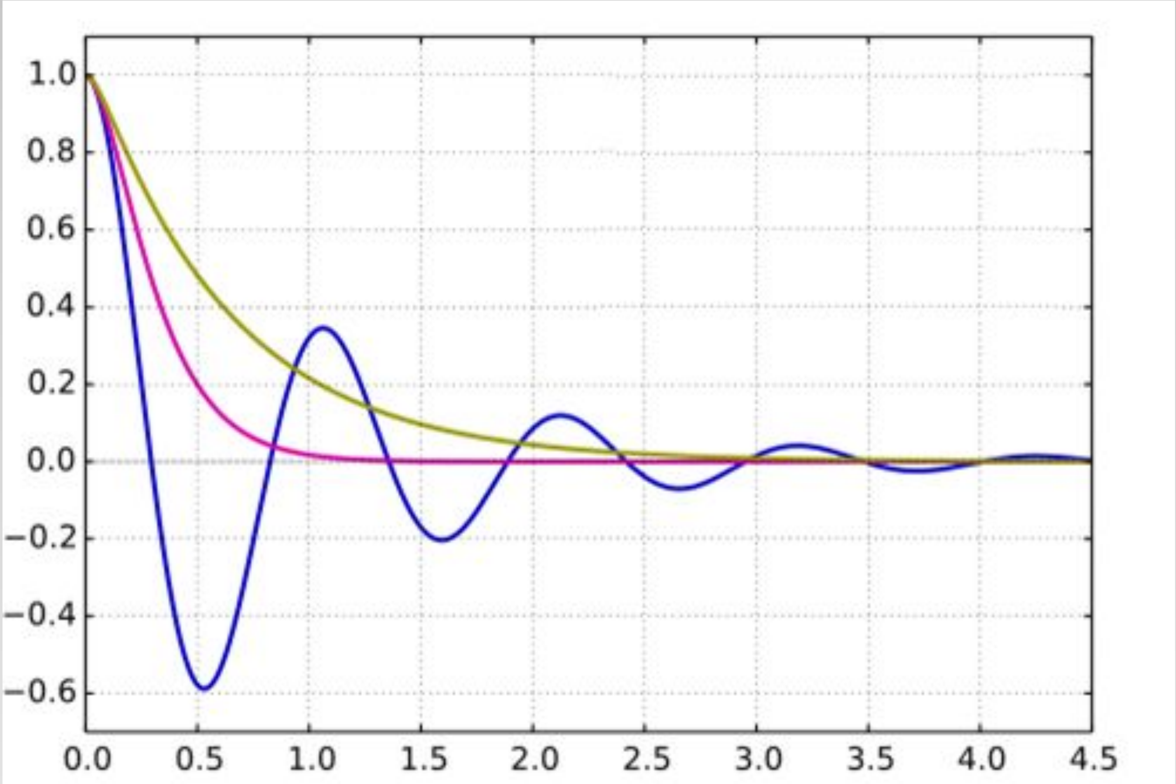


TYPES OF DAMPING OSCILLATIONS

Over-damped

Critically damped

Under damped



TYPES OF DAMPING OSCILLATIONS

Stringed instruments "Under-damped"

Toilet flush button "Over-damped"

Gun "Critical"

TYPES OF DAMPING

Material damping -1

(internal friction, mechanical hysteresis)

Friction at joints -2

Added layers of materials with high loss factors -3

(e.g. viscoelastic materials)

Hydraulic dampers (shock absorbers, hydromounts) -4

Air/oil pumping: squeeze-film damping -5

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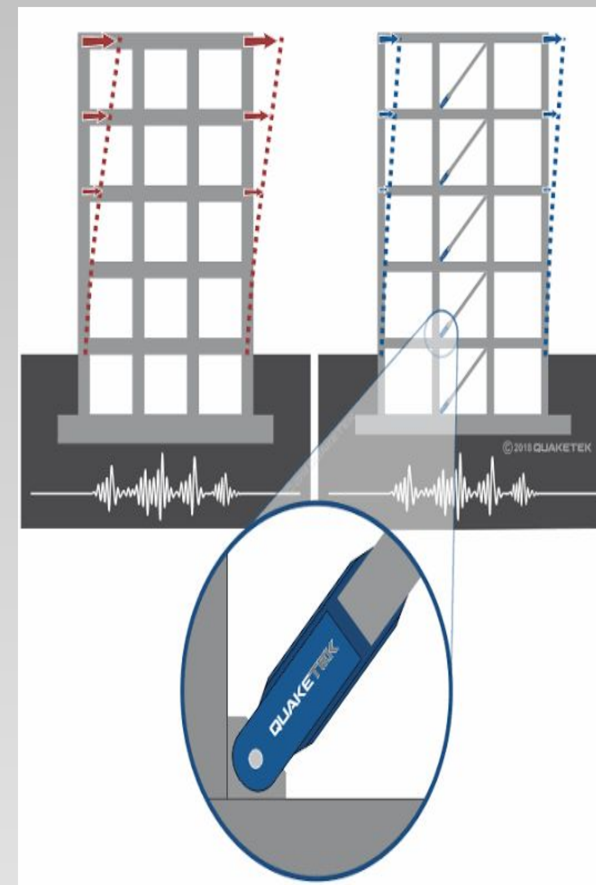
HYDRAULIC DAMPERS

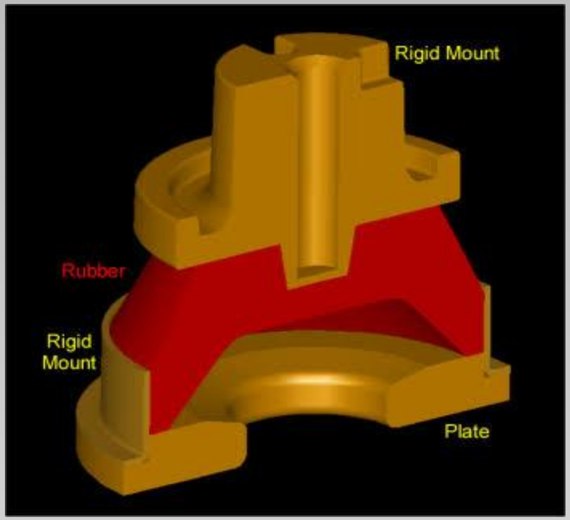
Used for bridges, buildings and cars to absorb the impact from the bumps and earthquakes.

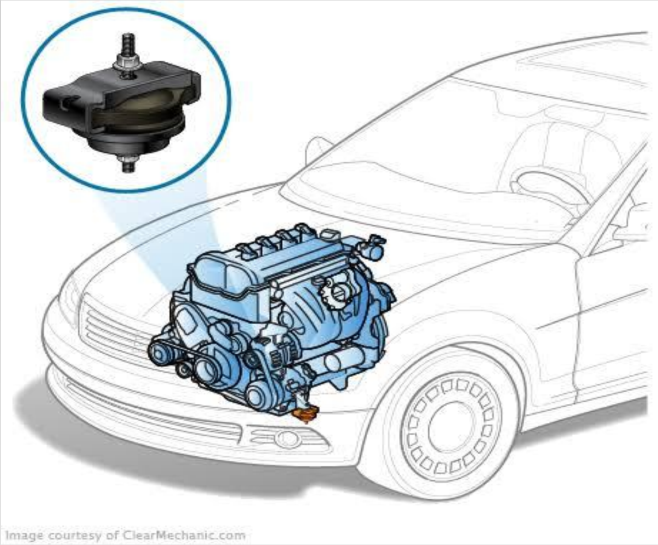


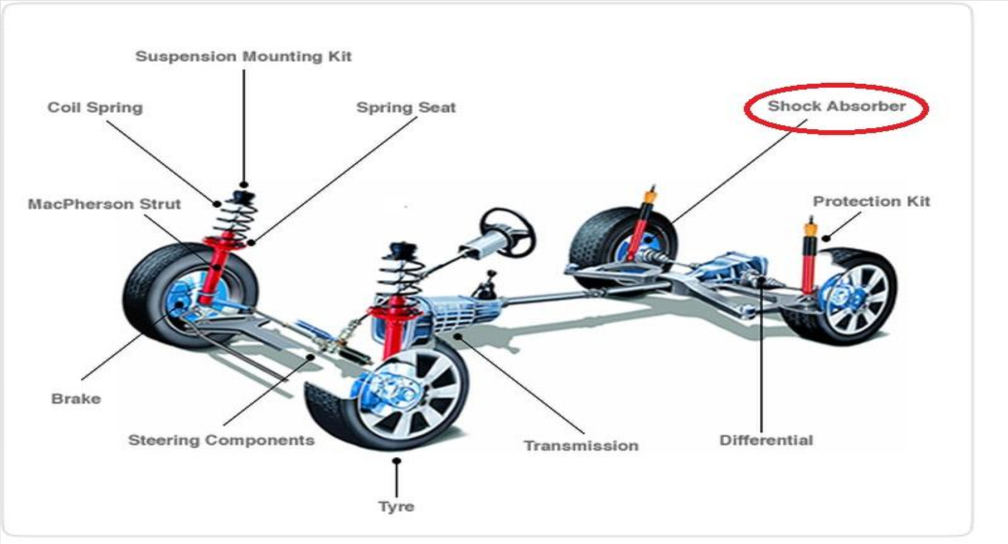
In Bridges

In Buildings

HYDRAULIC DAMPERS



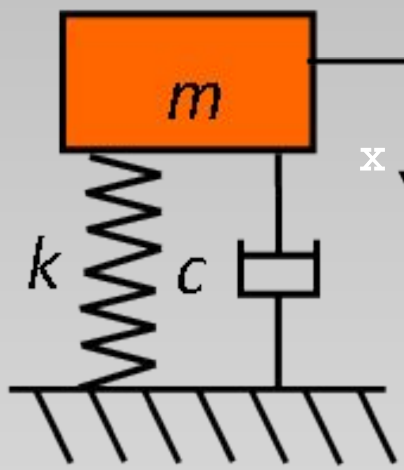


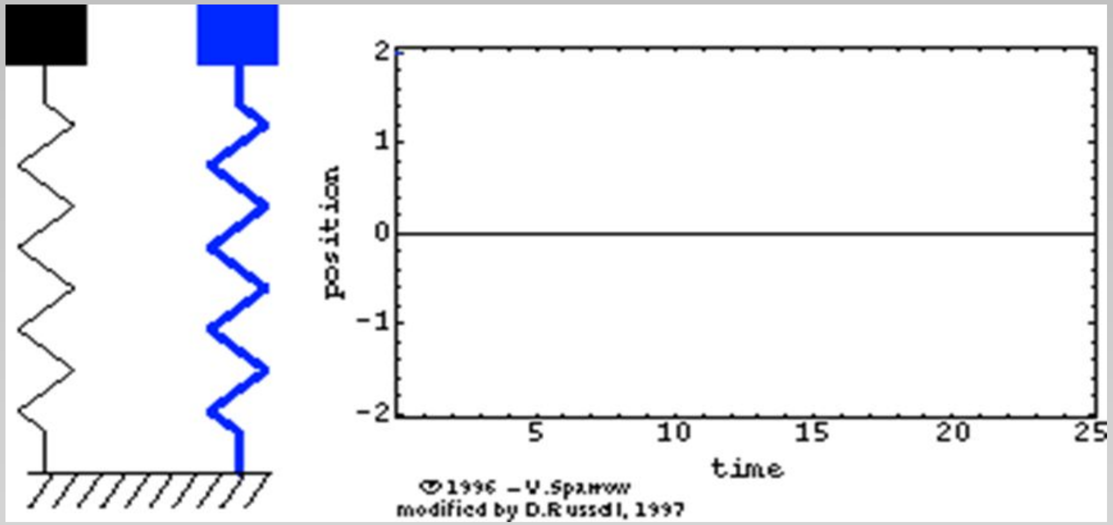


Hydro-mounts in car

Shock absorber in car

REVIEW OF DAMPING MECHANISMS





The equation of motion is

$$m\ddot{x} + c\dot{x} + kx = 0$$

inertia force

damping force

stiffness force

FREE VIBRATION EFFECT OF DAMPING

- The under-damped displacement of the mass is given by

$$x = Xe^{-\zeta\omega_n t}\sin\left(\omega_d t + \phi\right)$$

Exponential decay term: $Xe^{-\zeta\omega_n t}$

Oscillatory term: $\sin\left(\omega_d t + \phi\right)$

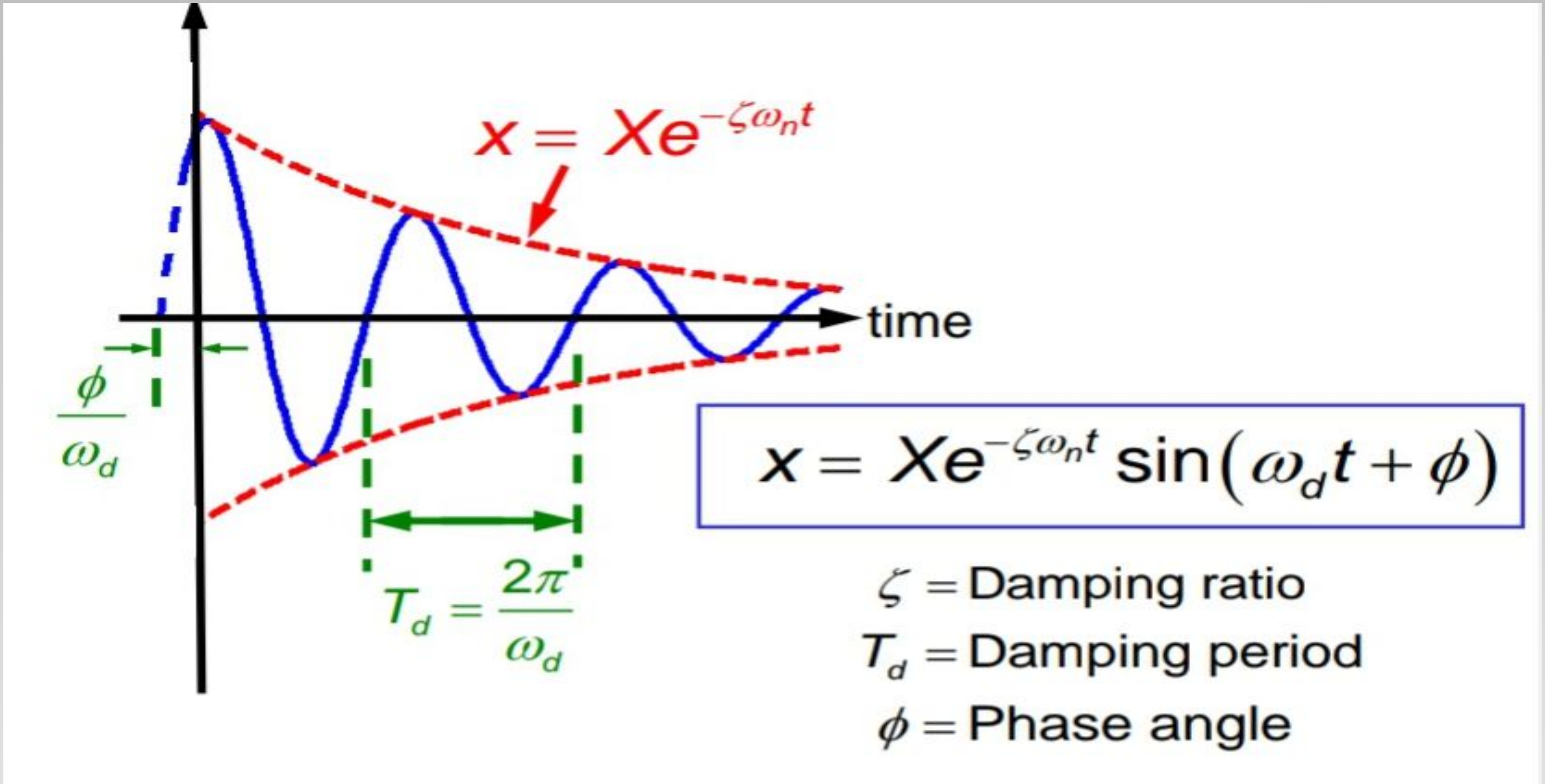
ζ = Damping ratio = $c/\left(2m\omega_n\right)$ $\quad \left(0 < \zeta < 1\right)$

ω_n = Undamped natural frequency = $\sqrt{k/m}$

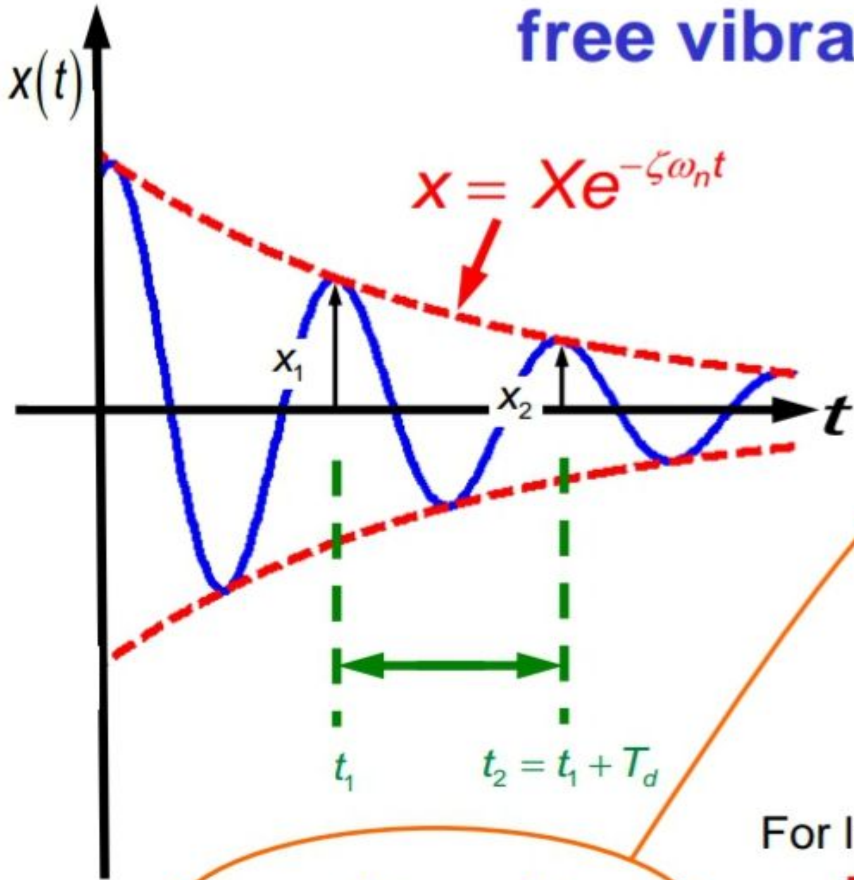
ω_d = Damped natural frequency = $\omega_n\sqrt{1-\zeta^2}$

ϕ = Phase angle

Free vibration effect of damping



Measurement of Damping –decay of free vibration



$$T_d = \frac{2\pi}{\omega_d} = \frac{2\pi}{\omega_n\sqrt{1-\zeta^2}}$$

Measure the amplitude of two successive cycles

$$\frac{x_1}{x_2} = e^{\zeta\omega_n T_d}$$

$$\delta = \ln\left(\frac{x_1}{x_2}\right) = \zeta\omega_n T_d$$

Logarithmic decrement

So $\delta = \dfrac{2\pi\zeta}{\sqrt{1-\zeta^2}}$

For light damping $\delta \approx 2\pi\zeta$

So $\zeta \approx \dfrac{\delta}{2\pi}$ ← measured

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THANKS

FOR YOUR TIME