Answer on Question #70362, Physics / Other

The suspension of a car can be considered to form a mass-spring system with a undamped frequency of vibration of 0.24 Hz and a damping ratio, ζ=0.5. The car is driven along a road with a series of ruts that provide a periodic, sinusoidal driving force to the suspension. If the ruts are evenly spaced with a distance 2.1 m between their crests what speed must the driver not drive at to avoid damaging the car?

Solution:

From given the undamped frequency

$$\omega_0 = 2\pi f = 2\pi \times 0.24$$

Period of forcing is

$$T = \frac{d}{v} = \frac{2.1\ m}{v}$$

where v is speed.

Hence

$$\omega = \frac{2\pi}{T} = \frac{2\pi v}{d}$$

The peak amplitude occur at a frequency ratio of

$$\frac{\omega}{\omega_0} = \sqrt{1 - 2\zeta^2}$$

At resonance

$$\frac{2\pi v}{d} = 2\pi f\sqrt{1 - 2\zeta^2}$$

$$v = fd\sqrt{1 - 2\zeta^2} = 0.24 \times 2.1 \times \sqrt{1 - 2 \times 0.5^2} = 0.356\ m/s$$

Answer: $0.356\ m/s$