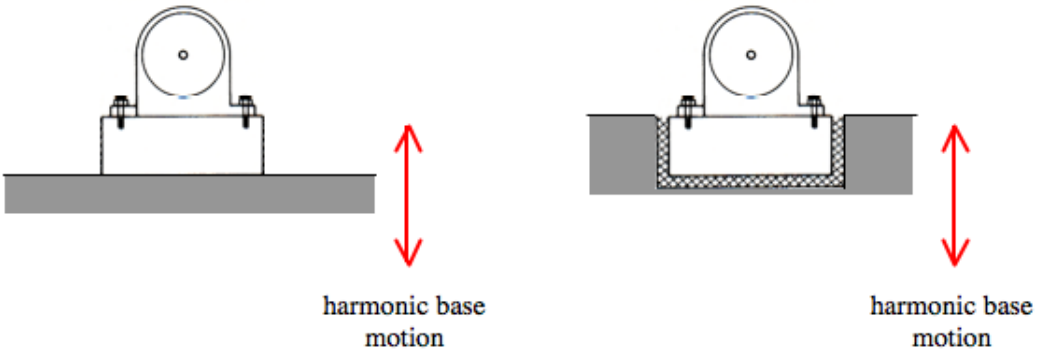
Example V.1.1

A sensitive instrument having a total mass of $113kg$ experiences an undesirable inertial load when rigidly attached to a base that is oscillating with a frequency of $20Hz$. It is proposed to mount the instrument on a rubber pad to reduce this load on the instrument. If the pad provides a damping producing a damping ratio of $\zeta = 0.10$, what stiffness must the pad have in order to produce a 60 percent reduction in transmitted force to the instrument?



$$\begin{cases} T = 1 - 0.6 = 0.4 \\ \zeta = 0.1 \\ \Omega = (20)2\pi = 40\pi \ \frac{rad}{sec} \end{cases}$$

$$T^2 = \frac{1 + 4\zeta^2 r^2}{(1-r^2)^2 + 4\zeta^2 r^2}$$

w/ $r \triangleq \Omega/\omega_n$

$$r^4 - \left[2 + 4\zeta^2\left(1 - \frac{1}{T^2}\right)\right] r^2 + 1 - \frac{1}{T^2} = 0$$

→ quadratic function in r^2

→ Since $T < 1 \Rightarrow$ only one real root for r

Sub. in the above design parameters & quadratic formula used to get:

$r^2 = -1.565,\ \boxed{3.355}$

$\omega_n^2 = \Omega^2 / r^2$

$\frac{R}{m} =$

$\hookrightarrow \quad R = m\Omega^2 / r^2$

$= (113)(40\pi)/3.355$

$= 5.322 \times 10^5 \frac{N}{m}$

$X_{static} = mg/R$

$= (113)(9.806)/5.322 \times 10^5$

$= 2.08\ mm$