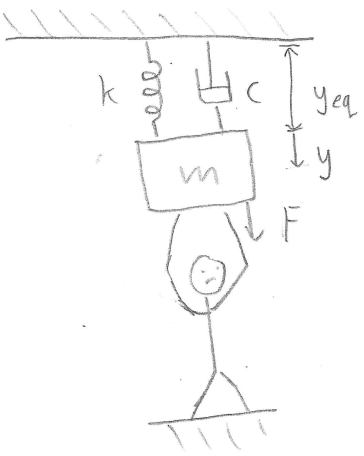
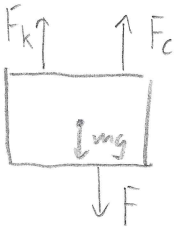
20-R-VIB-DY-35 Beginner

A new innovative workout machine requires the user to shake a weight of mass $m = 50kg$. The mass is attached to the ceiling via a spring, $k = 100\ N/m$, and a damper, $c = 15\ Ns/m$. Given that the periodic force can be described as $F = 50\sin 2t$, determine the amplitude of vibration. Initially at rest.

Solution:



FBD



mg & ky_{eq} cancel out

$$\Sigma F_y = -ma_y$$

$$F_k + F_c - F = -ma_y$$

$$ky + c\dot{y} + m\ddot{y} = 50\sin 2t$$

$\omega_n = \sqrt{\frac{k}{m}} = \sqrt{2}$

$c_c = \sqrt{4mk} = 100\sqrt{2}$

$$D = \frac{F_0/k}{\sqrt{\left[1-\left(\frac{\omega_0}{\omega_n}\right)^2\right]^2 + \left[2\frac{c}{c_c}\frac{\omega_0}{\omega_n}\right]^2}}$$

$F_0 = 50$
$k = 100$
$c = 15$
$\omega = 2$

$$= 0.4789\ m$$