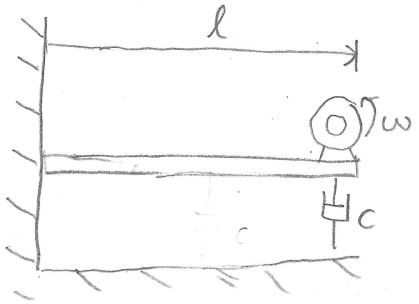
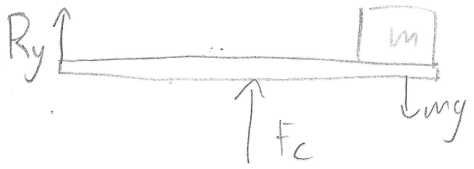
20-R-VIB-DY-42 Intermediate

A $m = 10$ kg eccentric motor is mounted at the end of a $\ell = 2$ m solid horizontal bar which is attached to a wall. The eccentric motion can be described as a 5 kg mass located 0.25 m from the axis of rotation ($w = 35$ rad/s). A $c = 25$ Ns/m damper supports the bar at the midpoint. Bar deflects 0.05 m when the motor is off, find displacement at $t = 10$ s.



Solution



$ky = F = mg$

$k = \frac{mg}{y} = 1962$

$w_n = \sqrt{\frac{k}{m}} = 14$ rad/s

$c_c = \sqrt{4mk} = 280.14$ Ns/m

$F_o = mrw^2 = 5 \times 0.25 \times 35^2 = 1531.25$ N

$$D = \frac{F_o/k}{\sqrt{\left[1-\left(\frac{w}{w_n}\right)^2\right]^2 + \left[2\frac{c}{c_c}\frac{w}{w_n}\right]^2}} = 0.148$$

$$\phi = \tan^{-1}\left[\frac{2\frac{c}{c_c}\frac{w}{w_n}}{1-\left(\frac{w_o}{w_n}\right)^2}\right] \qquad \phi = -0.08479$$

$$y(t) = 0.148 \sin(35t + 0.08479)$$

$$y(10) = -0.14497$$