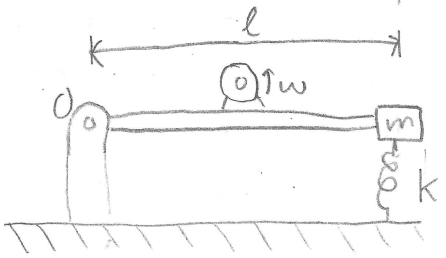
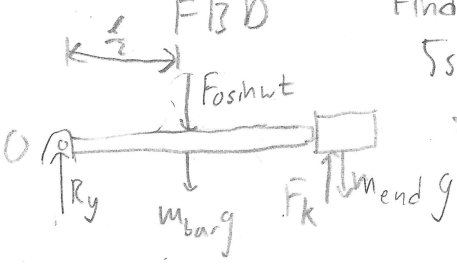
20-R-VIB-DY-33 Advanced

An eccentric motor is mounted (half-way) on a 5kg bar which is $\ell = 2m$ long. The eccentric motion is equivalent to a 2.5kg mass located 0.1m from the axis of rotation. A spring, $k = 25\ N/m$, is attached to a 10kg mass which is fixed to the end of the bar. $w = 2\ rad/s$



Solution:



Find angle at 5s if, starting from rest

$\Sigma M_O = I_O \alpha \qquad m_{end} a \ell + k y \ell - F_o \sin wt \frac{\ell}{2} = -\frac{1}{3} m_{bar} \ell^2 \ddot{\theta}$

$y = \theta \ell \qquad a = \ell \ddot{\theta}$

$m_{end} \ell^2 \ddot{\theta} + k \theta \ell^2 - F_o \sin wt \frac{\ell}{2} = -\frac{1}{3} m_{bar} \ell^2 \ddot{\theta}$

$\ddot{\theta} \ell^2 \left(m_{end} + \frac{m_{bar}}{3}\right) + k\ell^2 \theta = F_o \sin wt \frac{\ell}{2}$ $\qquad m_{end} + \frac{m_{bar}}{3} = m_{tot}$

$\theta_p = D \sin wt \qquad w_n = \sqrt{\frac{k}{m_{tot}}}$

$\ddot{\theta}_p = -D w^2 \sin wt$

$-D w^2 \sin wt\ \ell^2 (m_{tot}) + k\ell^2 (D \sin wt) = F_o \sin wt \frac{\ell}{2}$

$F_o = m_e r w^2$

$$D = \frac{m_e r w^2}{2\ell (k - w\, m_{tot})} = \frac{F_o / k}{2\ell \left[1 - \left(\frac{w}{w_n}\right)^2\right]} \doteq 0.15$$

$\theta_p = D \sin(wt) = 0.15 \sin 2t$

@ $t = 5 \qquad \theta = -0.0816$ rad