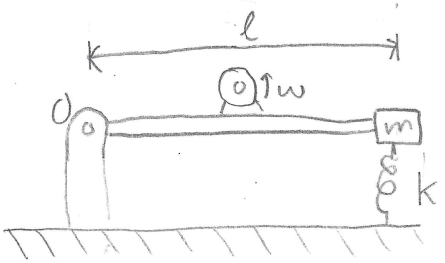
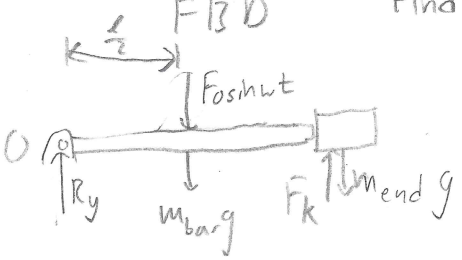
20-R-VIB-DY-33 Advanced

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 time at 5s.



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

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

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

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

$\theta_p = D\sin\omega t$

$\ddot{\theta}_p = -D\omega^2 \sin\omega t$

$-D\omega^2 \sin\omega t\, \ell^2 (m_{tot}) + k\ell^2 (D\sin\omega t) = F_o \sin\omega t \frac{\ell}{2}$

$F_o = m_e r \omega^2$

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

$x_p = D\sin(\omega t) = 0.15 \sin 2t$

@ $t = -0.0816$ rad