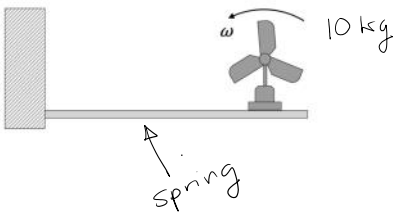
Question 1:

A 10 kg fan is fixed to a lightweight beam. The static weight of the fan deflects the beam by 20 mm. If the blade is designed to spin at ω = 15 rad/s, and the blade is mounted off-center (equivalent to a 1.5 kg mass at 50 mm from the axis of rotation), determine the steady-state amplitude of vibration.



10kg

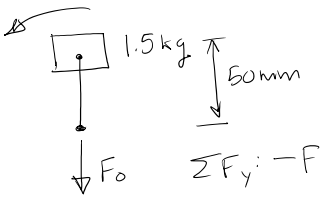
$\Sigma F_y: -F_G = kx$

$-mg = k(-0.02m)$ (10 kg)

$k = \frac{10kg(9.81m/s^2)}{0.02m} = 4905 N/m$

$\omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{4905 N/m}{10kg}} = 22.15 rad/s$

$\omega = \omega_o = 15 rad/s$ const.



$\Sigma F_y: -F_o = m_e a_y$

$F_o = (1.5kg)(11.25 m/s^2)$

$= 16.875 N$

$a_y = -\omega_o^2 r$

$= -(15 rad/s)^2 (0.05 m)$

$= -11.25 m/s^2$

$$D = \frac{F_o/k}{1 - \left(\frac{\omega_o}{\omega_n}\right)^2} = \frac{16.875N/4905N/m}{1 - \left(\frac{15 rad/s}{22.15 rad/s}\right)^2} = 0.00635 m = 6.35 mm$$