Chapter 3
Harmonically Excited Vibration

(3.1) (a) $\delta = \frac{W}{k} = \frac{50}{4000} = 0.0125$ m

(b) $\delta_{st} = \frac{F_0}{k} = \frac{60}{4000} = 0.015$ m

(c) $\omega_n = \sqrt{\frac{k}{m}} = \left(\frac{4000 \times 9.81}{50}\right)^{1/2} = 28.0143$ rad/sec

$\omega = cm = 27.4293$ rad/sec

$x = \delta_{st}\left|\frac{1}{1 - \left(\frac{\omega}{\omega_n}\right)^2}\right| = 0.015\left|\frac{1}{1 - \left(\frac{27.4293}{28.0143}\right)^2}\right| = 0.0185$ m

(3.2) $\tau_b = \frac{2\pi}{\omega_n - \omega} = \frac{2\pi}{2\pi(400 - 25.6)} = 5$ sec

(3.3) $k = 4000$ N/m, $m = 10$ kg, $F(t) = 400 \cos 10t$ N

$F_0 = 400$ N, $\omega = 10$ rad/s

$\omega_n = \sqrt{\frac{k}{m}} = 20$ rad/s, $\frac{\omega}{\omega_n} = \frac{10}{20} = 0.5 < 1$

Response is given by Eq. (3.9):

$x(t) = \left(x_0 - \frac{F_0}{k - m\omega^2}\right)\cos\omega_n t + \left(\frac{\dot{x}_0}{\omega_n}\right)\sin\omega_n t + \frac{F_0}{k - m\omega^2}\cos\omega t$

(a) $x_0 = 0.1$, $\dot{x}_0 = 0$:

Eq. (E-1) becomes

$x(t) = \left\{0.1 - \frac{400}{4000 - 10(100)}\right\}\cos 20t + \frac{400}{4000 - 10(100)}\cos 10t$

$= -0.033333 \cos 20t + 0.133333 \cos 10t$ (E-2)

(b) $x_0 = 0$, $\dot{x}_0 = 10$:

Eq. (E-1) becomes

$x(t) = \left\{0 - \frac{400}{4000 - 10(100)}\right\}\cos 20t + \frac{10}{20}\sin 20t$

$\quad + \left\{\frac{400}{4000 - 10(100)}\right\}\cos 10t$

$= -0.133333 \cos 20t + 0.5 \sin 20t + 0.133333 \cos 10t$ (E-3)

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Mechanical Vibrations Rao 4th Solutions Manual

RJ Alexander

Mechanical Vibrations Rao 4th Solutions Manual:

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