

Motorcycle Engine Vibration Problem

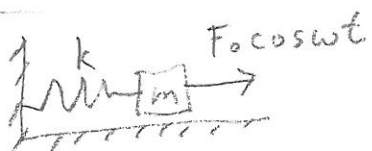
Given: $\omega = \frac{5000 \left[\frac{\text{rev}}{\text{min}} \right] \times 2\pi \left[\frac{\text{rad}}{\text{rev}} \right]}{60 \left[\frac{\text{sec}}{\text{min}} \right]} = 524 \text{ rad/s}$

$F_0 = 20 \text{ N}$ $m = 40 \text{ kg}$ $k = 40,000 \text{ N/m}$

Find: X (amplitude of steady-state response)

Sol'n: $X = \frac{F_0}{k - m\omega^2} = \frac{20}{40,000 - 40 \times 524^2} = 1.83 \times 10^{-6} \text{ m}$ (verysmall)

Problem 2.5

Given: 

$$\omega_{\text{beat}} = |\omega_n - \omega| = \frac{2\pi}{0.2\pi} = 10 \text{ rad/s}$$

$$\omega_{\text{fast}} = \frac{\omega_n + \omega}{2} = \frac{2\pi}{0.02\pi} = 100 \text{ rad/s}$$

Find: ω, ω_n

Sol'n: $\omega_{\text{fast}} = \frac{\omega_n + \omega}{2} = 100$ $\therefore \omega = 200 - \omega_n$

$$\omega_{\text{beat}} = |\omega_n - \omega|$$

$$10 = |\omega_n - (200 - \omega_n)| = |2\omega_n - 200|$$

$$2\omega_n - 200 = 10$$

$$\omega_n = \frac{10 + 200}{2} = 105 \text{ rad/s}$$

$$\omega = 200 - \omega_n$$

$$= 200 - 105$$

$$= 95 \text{ rad/s}$$

or

$$-(2\omega_n - 200) = 10$$

$$\omega_n = \frac{-10 + 200}{2} = 95 \text{ rad/s}$$

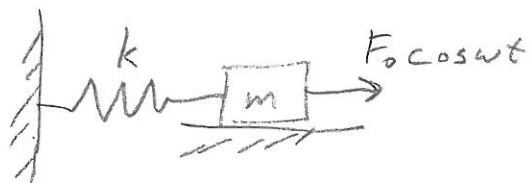
$$\omega = 200 - \omega_n$$

$$= 200 - 95$$

$$= 105 \text{ rad/s}$$

Problem 2.6⁷

Given:



$$k = 1000 \frac{\text{N}}{\text{m}}$$

$$m = 10 \text{ kg}$$

$$F_0 = 100 \text{ N}$$

$$\omega = 8.162 \text{ rad/s}$$

$$x_0 = 0.01 \text{ m}$$

$$v_0 = 0.01 \text{ m/s}$$

Find: Plot of response

$$\text{Sol'n: } x(t) = \frac{v_0}{\omega_n} \sin \omega_n t + \left(x_0 - \frac{F_0}{k - m\omega^2} \right) \cos \omega_n t + \frac{F_0}{k - m\omega^2} \cos \omega t$$

$$\omega_n = \sqrt{\frac{k}{m}} = 10 \text{ rad/s}$$

$$x(t) = 0.001 \sin(10t) - 0.2896 \cos(10t) + 0.2996 \cos(8.162t)$$

- See printout

Homework 2.6⁶, 2.7⁸, 2.15¹⁵

MECE 340 Vibrations - Problem 2.6⁷

k	1000	N/m
m	10	kg
F0	100	N/m
w	8.162	rad/s
x0	0.01	m
v0	0.01	m/s
wn	10	
dt	0.02	s

t	x(t)
0	0.01
0.02	0.011988
0.04	0.017423
0.06	0.025932
0.08	0.036917
0.1	0.049589
0.12	0.06301
0.14	0.076136
0.16	0.087878
0.18	0.097158
0.2	0.102968
0.22	0.104429
0.24	0.100839
0.26	0.091724
0.28	0.076868
0.3	0.056342
0.32	0.030509
0.34	2.67E-05
0.36	-0.03417
0.38	-0.0709
0.4	-0.10878
0.42	-0.14627
0.44	-0.18174
0.46	-0.21355
0.48	-0.2401

