

## Chapter 2

### Free Vibration of Single Degree of Freedom Systems

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2.1  $\xi_{yt} = 5 \times 10^{-3} \text{ m}$   
 $\omega_n = \left(\frac{g}{\xi_{yt}}\right)^{1/2} = \left(\frac{9.81}{5 \times 10^{-3}}\right)^{1/2} = 44.2945 \text{ rad/sec} = 7.0497 \text{ Hz}$

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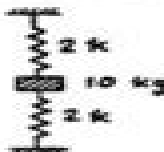
2.2  $\tau_n = 0.21 \text{ sec} = 2\pi \sqrt{\frac{m}{k}}$  ,  $\sqrt{m} = 0.21 \sqrt{k}/2\pi$   
 (i)  $(\tau_n)_{\text{new}} = \frac{2\pi \sqrt{m}}{\sqrt{k_{\text{new}}}} = \frac{2\pi \sqrt{m}}{\sqrt{1.5k}} = \frac{2\pi \left(\frac{0.21 \sqrt{k}}{2\pi}\right)}{\sqrt{1.5k}} = 0.1715 \text{ sec.}$   
 (ii)  $(\tau_n)_{\text{new}} = \frac{2\pi \sqrt{m}}{\sqrt{k_{\text{new}}}} = \frac{2\pi \sqrt{m}}{\sqrt{0.5k}} = 2\pi \left(\frac{0.21 \sqrt{k}}{2\pi}\right) \frac{1}{\sqrt{0.5k}} = 0.2970 \text{ sec.}$

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2.3  $\omega_n = 62.832 \text{ rad/sec} = \sqrt{\frac{k}{m}}$  ,  $\sqrt{m} = \sqrt{k}/62.832$   
 when spring constant is reduced,  $\omega_n$  decreases.  
 $(\omega_n)_{\text{new}} = 0.55 \omega_n = 34.5576 \text{ rad/sec} = \sqrt{\frac{k_{\text{new}}}{m_{\text{new}}}} = \sqrt{\frac{k-800}{m}}$   
 $\sqrt{\frac{k-800}{k}} \times 62.832 = 34.5576$  ,  $\sqrt{\frac{k-800}{k}} = 0.55$   
 $\frac{k-800}{k} = (0.55)^2 = 0.3025$   
 $k = 1146.9534 \text{ N/m}$   
 $\sqrt{m} = \sqrt{k}/62.832$  ;  $m = k/62.832^2 = \frac{1146.9534}{3947.8602}$   
 $m = 0.2905 \text{ kg}$

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2.4  $k = 100 / \left(\frac{10}{1000}\right) = 10000 \text{ N/m}$   
 $\omega_n = \sqrt{\frac{k_{\text{eq}}}{m}} = \sqrt{\frac{4k}{m}} = \left(\frac{4 \times 10^4}{10}\right)^{1/2}$   
 $= 63.2456 \text{ rad/sec}$   
 $\tau_n = \frac{2\pi}{\omega_n} = \frac{6.2832}{63.2456} = 0.0993 \text{ sec}$

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# Chapter Two Solution Manual Rao Vibrations

**RJ Shavelson**



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