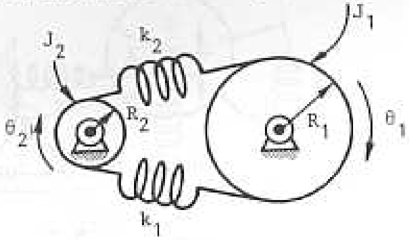
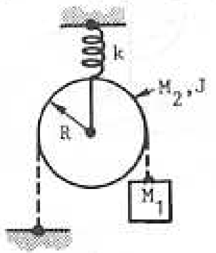
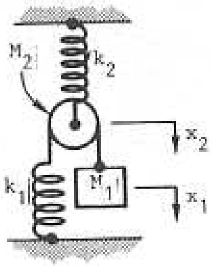
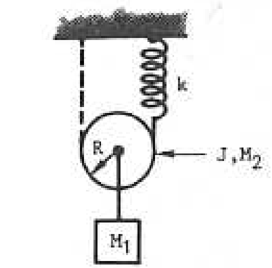
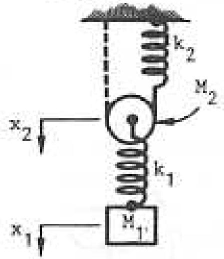
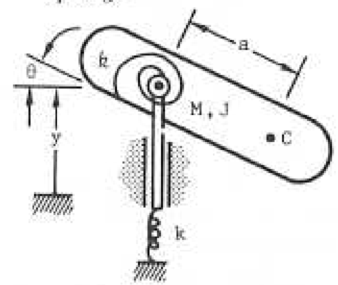
Table 6-3. Rigid Body, Torsion Spring Systems. *(Continued)*

Geometry	Natural Frequency (hertz), f_i	Mode Shape and Remarks
31. Two Anchored Pulleys, Two Springs 	$0, \quad \frac{1}{2\pi}\left[\frac{(k_1 + k_2)\ (R_1^2 J_2 + R_2^2 J_1)}{J_1 J_2}\right]^{1/2}$	$\begin{bmatrix}\tilde{\theta}_1 \\ \tilde{\theta}_2\end{bmatrix} = \begin{bmatrix}1 \\ \frac{R_1}{R_2}\end{bmatrix}, \begin{bmatrix}1 \\ \frac{-R_2 J_1}{R_1 J_2}\end{bmatrix}$
32. Mass, Spring-Supported Pulley 	$\frac{1}{2\pi}\left(\frac{k}{M_2 + 4M_1 + J/R^2}\right)^{1/2}$	--
33. Mass, Two Unequal Springs, Massive Pulley 	$\frac{1}{2^{3/2}\pi}\left\{\frac{k_1}{M_1} + \frac{k_2}{M_2} + \frac{4k_1}{M_2} \mp \left[\left(\frac{k_1}{M_1} + \frac{k_2}{M_2} + \frac{4k_1}{M_2}\right)^2 - \frac{4k_1 k_2}{M_1 M_2}\right]^{1/2}\right\}^{1/2}$	$\begin{bmatrix}\tilde{x}_1 \\ \tilde{x}_2\end{bmatrix}_i = \begin{bmatrix}1 \\ \frac{1}{2} - \frac{M_1}{2k_1}\ (2\pi f_i)^2\end{bmatrix}$ $i=1,2$ Pulley has no rotational inertia, i.e., $J = 0$.

34. Mass, Suspended Massive Pulley 	$\frac{1}{\pi}\left(\frac{k}{M_1 + M_2 + J/R^2}\right)^{1/2}$ J taken about center of pulley.	--
35. Mass, Two Unequal Springs, Massive Pulley 	$\frac{1}{2^{3/2}\pi}\left\{\frac{k_1}{M_1} + \frac{k_1}{M_2} + \frac{4k_2}{M_2} \mp \left[\left(\frac{k_1}{M_1} + \frac{k_1}{M_2} + \frac{4k_2}{M_2}\right)^2 - \frac{16k_1k_2}{M_1M_2}\right]^{1/2}\right\}^{1/2}$	$\begin{bmatrix}\tilde{x}_1 \\ \tilde{x}_2\end{bmatrix}_i = \begin{bmatrix}1 \\ 1 - \frac{M_1}{k_1}(2\pi f_i)^2\end{bmatrix}$ i=1,2 Pulley has no rotational inertia, i.e., J = 0.
36. Body, Torsion and Displacement Springs 	$\frac{\left\{f_y^2 + f_\theta^2 \mp \left[(f_y^2 + f_\theta^2)^2 - 4f_y^2 f_\theta^2(1 - Ma^2/J)\right]^{1/2}\right\}^{1/2}}{2^{1/2}(1 - Ma^2/J)^{1/2}}$ f_y and f_θ are the uncoupled frequencies (hertz): $f_y = \frac{1}{2\pi}\left(\frac{k}{M}\right)^{1/2}$, $f_\theta = \frac{1}{2\pi}\left(\frac{k}{J}\right)^{1/2}$	$\begin{bmatrix}\tilde{y} \\ \tilde{\theta}\end{bmatrix}_i = \begin{bmatrix}1 \\ \frac{1}{a}\left[1 - \frac{k}{M(2\pi f_i)^2}\right]\end{bmatrix}$ i=1,2 J taken about pivot. When a=0, the system is uncoupled and $\tilde{y}$ and $\tilde{\theta}$ are independent.