MDOF SYSTEMS

5.1–5.15. Use the free-body diagram method to derive the differential equations governing the motion of the systems shown in Figs. P5.1 to P5.15 using the indicated generalized coordinates. Make linearizing assumptions and write the resulting equations in matrix form.

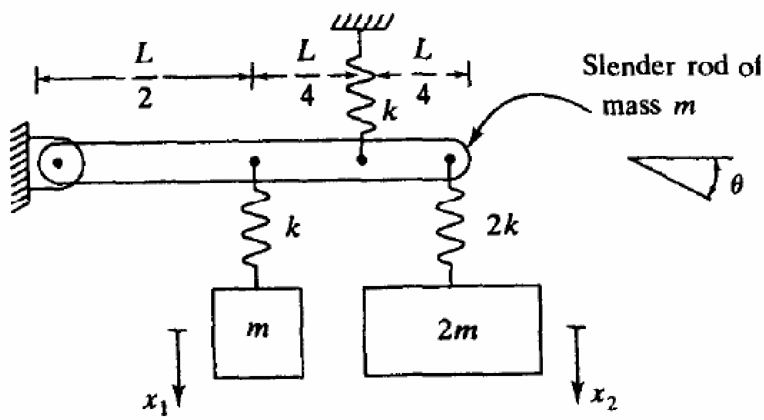
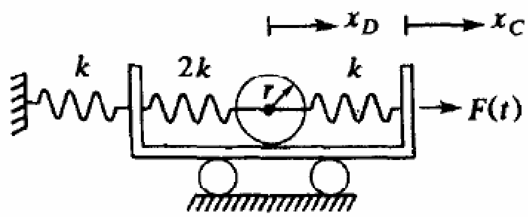


FIGURE P5.3



Thin disk of mass m and radius r rolls without slip relative to center of mass $2m$. x_D is absolute displacement of mass center of disk

FIGURE P5.6

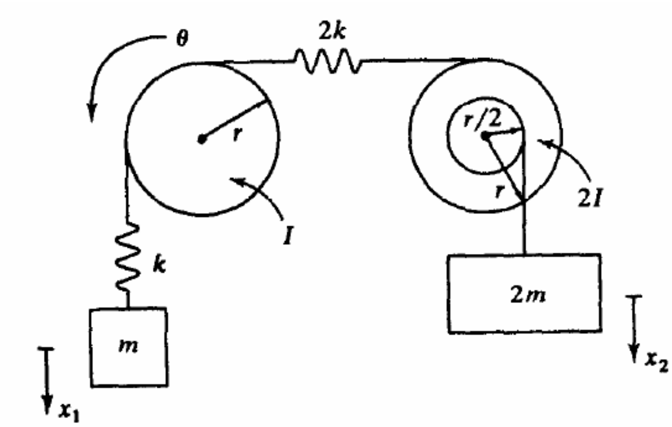
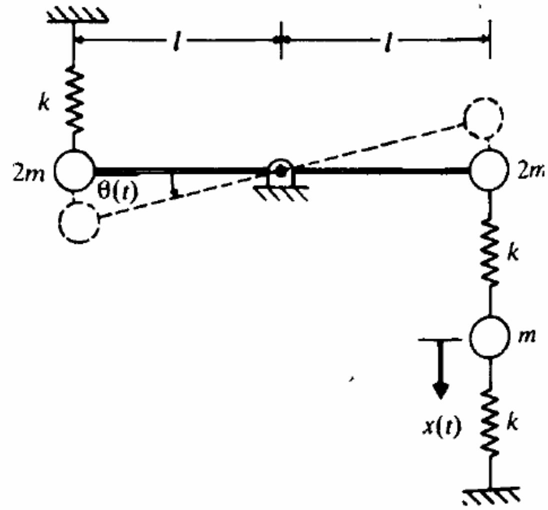


FIGURE P5.8

5.26. A rigid rod of negligible mass and length $2l$ is pivoted at the middle point and is constrained to move in the vertical plane by springs and masses, as shown in Fig. 5.28. Find the natural frequencies and mode shapes of the system.



6.1–6.5. Determine the natural frequencies and mode shapes for the two-degree-of-freedom systems shown. Graphically illustrate the mode shapes and identify any nodes.

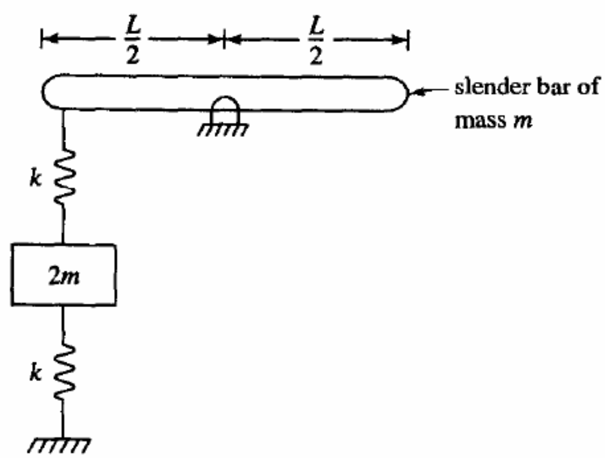
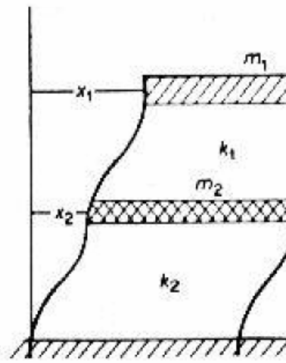


FIGURE P6.5

5-28 ساختمان دو طبقه شکل P5-28، یک سیستم با جرم متمرکز است که در آن $m_1=\frac{1}{2}m_2$ و $k_1=\frac{1}{2}k_2$ است. نشان دهید که مودهای طبیعی چنین است.

$$\left(\frac{x_1}{x_2}\right)_1=2 \qquad \omega_1^2=\frac{k_1}{2m_1}$$

$$\left(\frac{x_1}{x_2}\right)_2=-1 \qquad \omega_2^2=\frac{2k_1}{m_1}$$



شکل P5-28

6.31. The normalized mode shape vector for the lowest mode of a three-degree-of-freedom system is

$$\mathbf{X}_1 = \begin{bmatrix} 1.2 \\ -0.8 \\ 1.1 \end{bmatrix}$$

The stiffness matrix for the system is

$$\mathbf{K} = 10^5 \begin{bmatrix} 3.1 & -1.4 & 0 \\ -1.4 & 3.5 & -1.9 \\ 0 & -1.9 & 2.6 \end{bmatrix}$$

Determine the natural frequency corresponding to this mode.

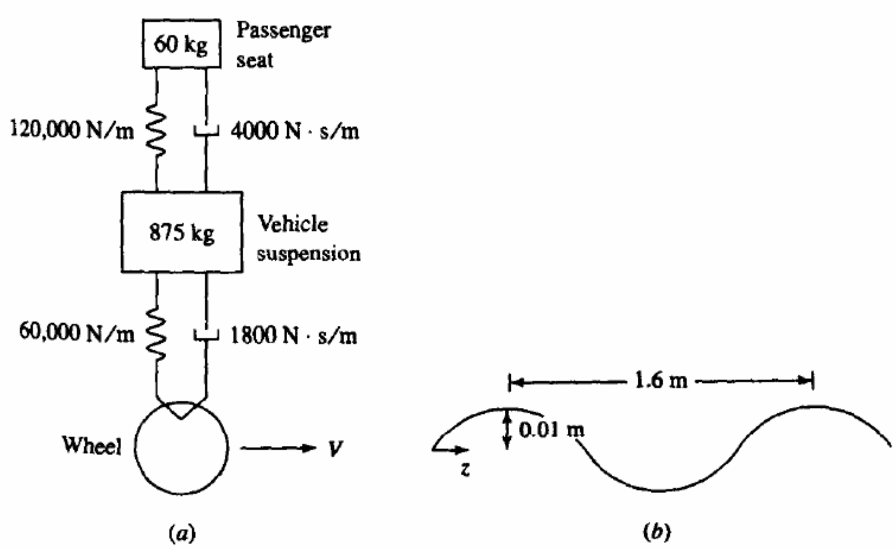
6.32. The mass matrix for a three-degree-of-freedom system is

$$\mathbf{M} = \begin{bmatrix} 1.5 & 0.6 & 0 \\ 0.6 & 2.4 & 0 \\ 0 & 0 & 3.1 \end{bmatrix}$$

Mode shape vectors corresponding to two-modes of this system are

$$\mathbf{X}_1 = \begin{bmatrix} 1.0 \\ 1.5 \\ 0.6 \end{bmatrix} \qquad \mathbf{X}_2 = \begin{bmatrix} 1.3 \\ -2.1 \\ 2.39 \end{bmatrix}$$

7.8. The system of Fig. P7.8 represents a simplified model of a vehicle suspension system and a passenger in the vehicle. The seat is modeled as a spring and viscous damper in parallel. For the suspension system shown, plot the acceleration amplitude of the passenger as a function of vehicle speed.



7-14 For the system of Fig. P7-14, determine the equilibrium position and its equation of vibration about it. Spring force = 0 when $\theta = 0$.

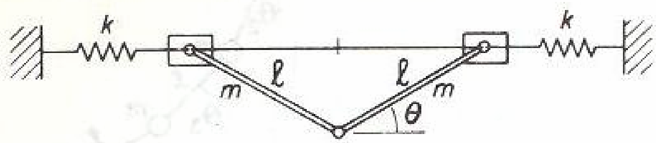


Figure P7-14.

7-15 Write Lagrange's equations of motion for the system shown in Fig. P7-15.

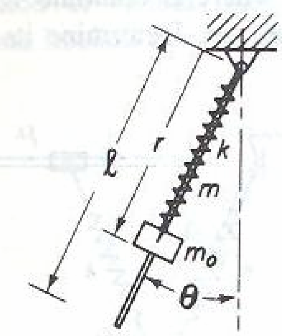


Figure P7-15.