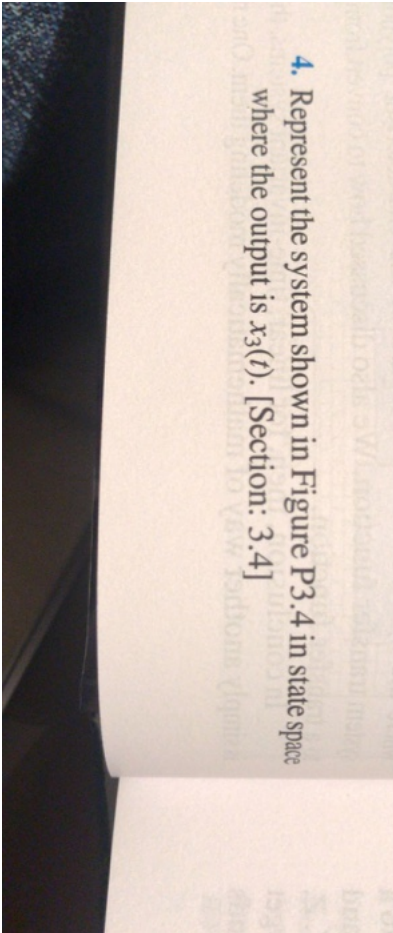


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(2 bookmarks)



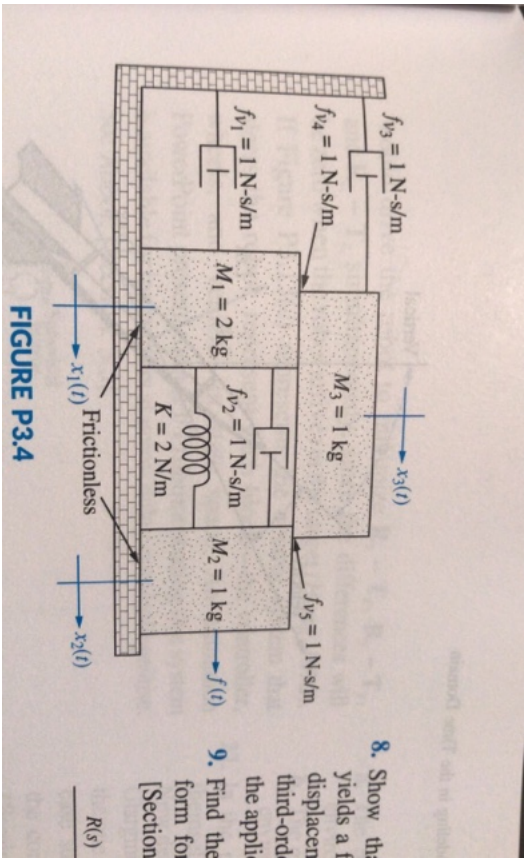


FIGURE P3.4

8. Show that the system yields a third-order transfer function for the applied force  $f(s)$ .

9. Find the form for the transfer function  $R(s)$ .

Consider  $x_1(t)$  and  $x_2(t)$  as the outputs in place of  $x_3(t)$ . Make

your answer clear please.  
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### Expert Answer



Anonymous answered this  
10 answers

Was this answer helpful?

$$M_1 = 2 \text{ kg}$$

$$M_2 = 1 \text{ kg}$$

$$M_3 = 1 \text{ kg}$$

$$k = 2 \text{ N/m}$$

$$f_{v_1} = 1 \text{ N-s/m} \quad ; \quad f_{v_2} = 1 \text{ N-s/m}$$

$$f_{v_3} = 1 \text{ N-s/m} \quad ; \quad f_{v_4} = 1 \text{ N-s/m}$$

for mass (1)  $M_1$  :-

$$M_1 \frac{d^2 x_1}{dt^2} + k_3 (x_1 - x_2) + f_{v_2} \frac{dx_1}{dt} + k_2 x_1 + f_{v_1} \left[ \frac{dx_1}{dt} - \frac{dx_3}{dt} \right] = 0$$

$$\Rightarrow 4 \frac{d^2 x_1}{dt^2} + 4 (x_1 - x_2) + 2 \frac{dx_1}{dt} + 4x_1 + 2 \left( \frac{dx_1}{dt} - \frac{dx_3}{dt} \right) = 0$$

$$\Rightarrow \boxed{4 \frac{d^2 x_1}{dt^2} + 4 \frac{dx_1}{dt} + 8x_1 - 4x_2 = 0} \quad \text{--- (1)}$$

for mass 2 ( $M_2$ ):-

$$M_2 \frac{d^2 x_2}{dt^2} + k_3 (x_2 - x_1) + f_{v_2} \left[ \frac{dx_2}{dt} - \frac{dx_3}{dt} \right] = f(t)$$

$$5 \frac{d^2 x_2}{dt^2} + 4 (x_2 - x_1) + 3 \left[ \frac{dx_2}{dt} - \frac{dx_3}{dt} \right] = f(t)$$

$$\Rightarrow \boxed{5 \frac{d^2 x_2}{dt^2} + 3 \frac{dx_2}{dt} - 3 \frac{dx_3}{dt} + 4x_2 - 4x_1 = f(t)} \quad \text{--- (2)}$$

for third mass ( $M_3$ ):-



$$\therefore \frac{d^2 x_4}{dt^2} = -2x_1 + x_2 - x_4 + \frac{1}{2}x_6 \quad \text{--- (7)}$$

for equation (2)

$$5 \frac{d^2 x_5}{dt^2} + 3 \frac{dx_5}{dt} - 3x_6 + 4x_2 - 4x_1 = f(t)$$

$$\therefore \frac{d^2 x_5}{dt^2} = \frac{4}{5}x_1 - \frac{4}{5}x_2 - \frac{3}{5}x_5 + \frac{3}{5}x_6 = \frac{f(t)}{5} \quad \text{--- (8)}$$

now for equation (3)

$$5 \frac{d^2 x_6}{dt^2} + 5 \frac{dx_6}{dt} - 3x_5 - 2x_4 + 5x_3 = 0$$

$$\frac{d^2 x_6}{dt^2} = -5x_3 + \frac{2}{5}x_4 + \frac{3}{5}x_5 - x_6 \quad \text{--- (9)}$$

from all the above equations

$$\begin{bmatrix} \frac{d^2 x_1}{dt^2} \\ \frac{d^2 x_2}{dt^2} \\ \frac{d^2 x_3}{dt^2} \\ \frac{d^2 x_4}{dt^2} \\ \frac{d^2 x_5}{dt^2} \\ \frac{d^2 x_6}{dt^2} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ -2 & 1 & 0 & -4 & 0 & \frac{1}{2} \\ \frac{4}{5} & -\frac{4}{5} & 0 & 0 & -\frac{3}{5} & \frac{3}{5} \\ 0 & 0 & -1 & \frac{2}{5} & \frac{3}{5} & -1 \end{bmatrix}$$

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