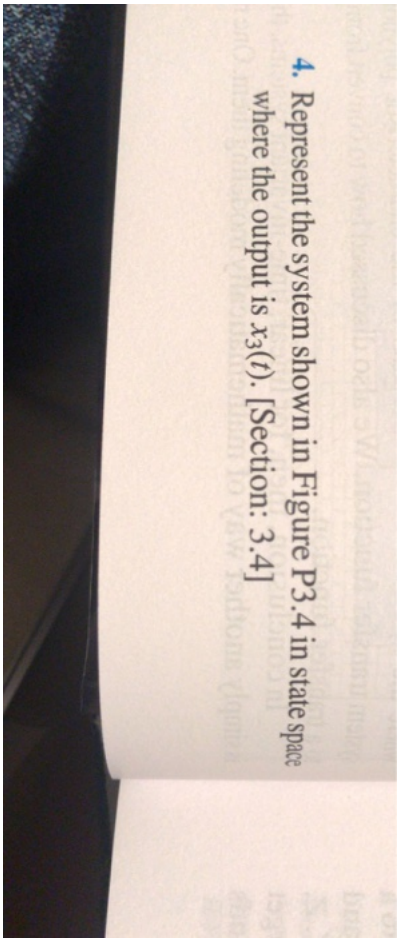
# Question: Consider x1(t) and x2(t) as the outputs in place of x3(t). Make y…





4. Represent the system shown in Figure P3.4 in state space where the output is $x_3(t)$. [Section: 3.4]

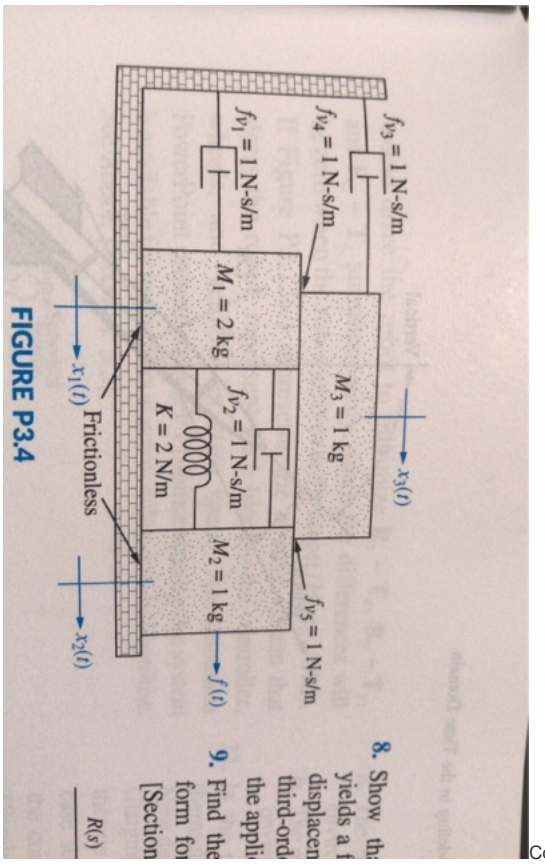



**FIGURE P3.4**

Consider x1(t) and x2(t) as the outputs in place of x3(t). Make your answer clear please.

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## Expert Answer

Anonymous answered this
10 answers

Was this answer helpful?

$M_1 = 2kg$

$M_2 = 1kg$

$M_3 = 1kg$

$K = 2\ N/m$

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

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

for mass (1) $M_1$ :-

$$M_1 \frac{d^2x_1}{dt^2} + K_3(x_1 - x_2) + f_{v_2}\frac{dx_1}{dt} + K_2 x_1 + f_{v_1}\left[\frac{dx_1}{dt} - \frac{dx_3}{dt}\right] = 0$$

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

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

for mass 2 ($M_2$):-

$$M_2\frac{d^2x_2}{dt^2} + K_3(x_2 - x_1) + f_{v_2}\left[\frac{dx_2}{dt} - \frac{dx_3}{dt}\right] = f(t)$$

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

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

for third mass ($M_3$):-

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

for equation (2)

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

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

now for equation (3)

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

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

from all the above equations

$$\begin{bmatrix} \frac{d^2x_1}{dt^2} \\ \frac{d^2x_2}{dt^2} \\ \frac{d^2x_3}{dt^2} \\ \frac{d^2x_4}{dt^2} \\ \frac{d^2x_5}{dt^2} \\ \frac{d^2x_6}{dt^2} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ -2 & 1 & 0 & -4 & 0 & 1/2 \\ 4/5 & -4/5 & 0 & 0 & -3/5 & 3/6 \\ 0 & 0 & -1 & 2/5 & 3/5 & -1 \end{bmatrix}$$

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