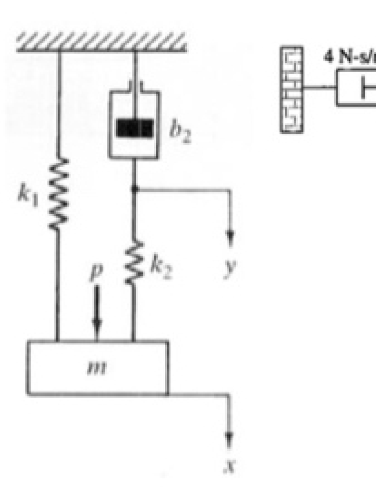
Question: Problem 1: Consider the mechanical system shown below i...

Problem 1: Consider the mechanical system shown below in Fig 1. The system is at rest initially. The displacement x and y are measured from their respective equilibrium positions. Assuming that p(t) is a step force input and the displacement x(t) is the output, obtain the transfer function of the system. Then, assuming that m = 0.1 Kg, b2 = 0.4 N-s/m, k1 = 6 N/m. k2 = 4 N/m, and p(t) is a step force of magnitude 10 N, obtain an analytical solution x(t)

Fig 1.



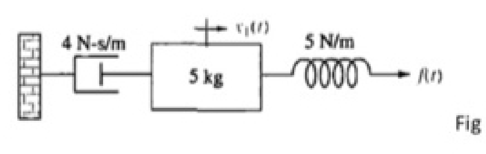


Fig 2.

Based on Chapter 2 sec 2.6 pages 61-69 of Control System Engineering, 6th edition.

This problem will progress through the next couple of weeks. I will add more questions to it building an entire system.

a. Find the equations of motion for the system. **Due Wed April 17. Make an appointment.**

Problem 2: Find the transfer function G(s) = X(s) / F(s) for the translation mechanical system shown in Fig 2.

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Expert Answer

Anonymous answered this
25 answers

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1) Given

P(t) is a step force input.

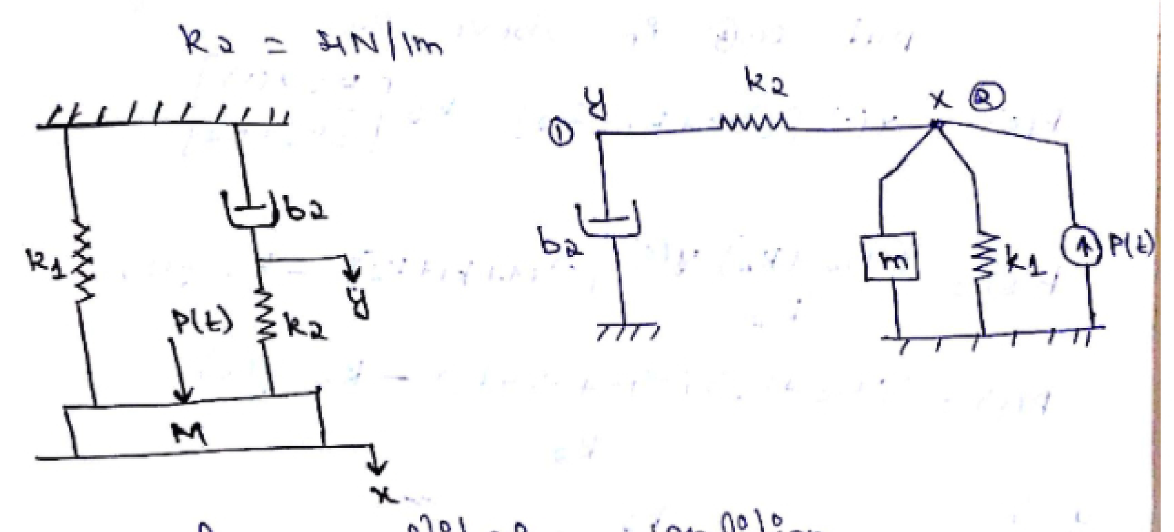
x(t) is displacement = output

$m = 0.1\,kg$

$b_2 = 0.4\,N\text{-}s/m$

$k_1 = 6\,N/m$

$k_2 = 4\,N/m$



under equilibrium condition,

apply D'Alembert's principle,

at node ①,

$$b_2\left(\frac{dy}{dt}\right) + k_2(y-x) = 0 \rightarrow ①$$

at node ②,

$$P(t) = M\frac{d^2x}{dt^2} + k_1x + k_2(x-y) \rightarrow ②$$

apply Laplace transform on both sides,

$$sB_2\,y(s) + k_2(y(s) - x(s)) = 0 \rightarrow ③$$

$$sB_2\,y(s) + k_2\,y(s) - k_2\,x(s) = 0$$

$$y(s)(sB_2 + k_2) = k_2\,x(s)$$

$$\boxed{y(s) = \frac{k_2\,x(s)}{sB_2 + k_2} \rightarrow ④}$$

$$P(s) = s^2M\,x(s) + k_1\cancel{x}(s) + k_2(-y(s) + x(s))$$

$$\boxed{P(s) = x(s)[s^2M + k_1 + k_2] - k_2\,y(s)}$$

put eq ④ in above eq.

$$P(s) = x(s)[s^2M + k_1 + k_2] - k_2\left[\frac{k_2\,x(s)}{sB_2 + k_2}\right]$$

$$\boxed{P(s) = \frac{(sB_2 + k_2)\,y(s)}{k_2}[s^2M + k_1 + k_2] - k_2\,y(s)}$$

$$P(s) = \frac{(sB_2 + k_2)(s^2M + k_1 + k_2) - k_2\;y(s)}{k_2}$$

$$\frac{y(s)}{P(s)} = \frac{k_2}{(sB_2 + k_2)(s^2M + k_1 + k_2) - k_2 \cdot k_2}$$

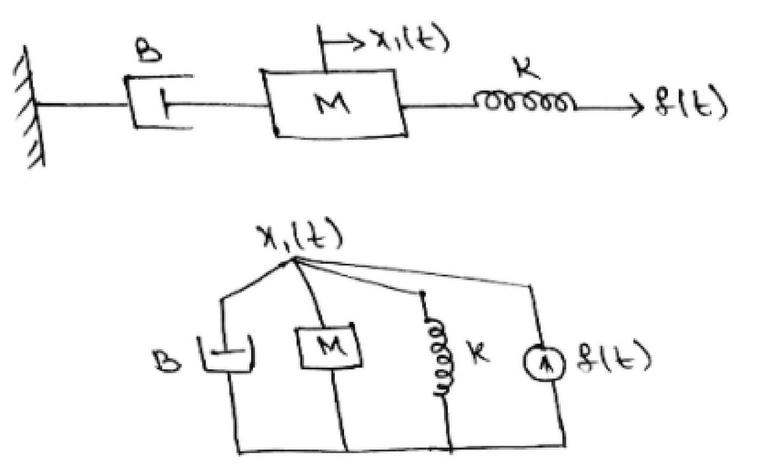
$$\frac{y(s)}{P(s)} = \frac{4\,N/m}{(s(0.4\,N\text{-}s/m) + 4\,N/m)\cdot(s^2(0.1\,kg) + 4 + 6) - 16\,N/m}$$

2) Given

$B = 4\,N\text{-}s/m$

$M = 5\,kg$

$K = 5\,N/m$



apply D'alemberts principle at node $x_1(t)$.

$$f(t) = M\frac{d^2x_1}{dt^2} + B\frac{dx_1}{dt} + Kx_1$$

apply laplace transform on both sides.

$$f(s) = s^2M\,x_1(s) + sB\,x_1(s) + K\,x_1(s)$$

$$\frac{f(s)}{x(s)} = (s^2M + sB + K)$$

$$\frac{x(s)}{f(s)} = \frac{1}{s^2M + sB + K}$$

$$G(s) = \frac{x(s)}{f(s)} = \frac{1}{5s^2 + 4s + 5}$$

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A: See answer 100% (1 rating)

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A: See answer 100% (1 rating)

Q: Matlab

A: See answer 100% (1 rating)

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