Question No. 3 For the block diagram below, find the following transfer functions:

$$\frac{C(s)}{E_2(s)},\ \frac{C(s)}{X(s)} \text{ and } \frac{C(s)}{R(s)}$$

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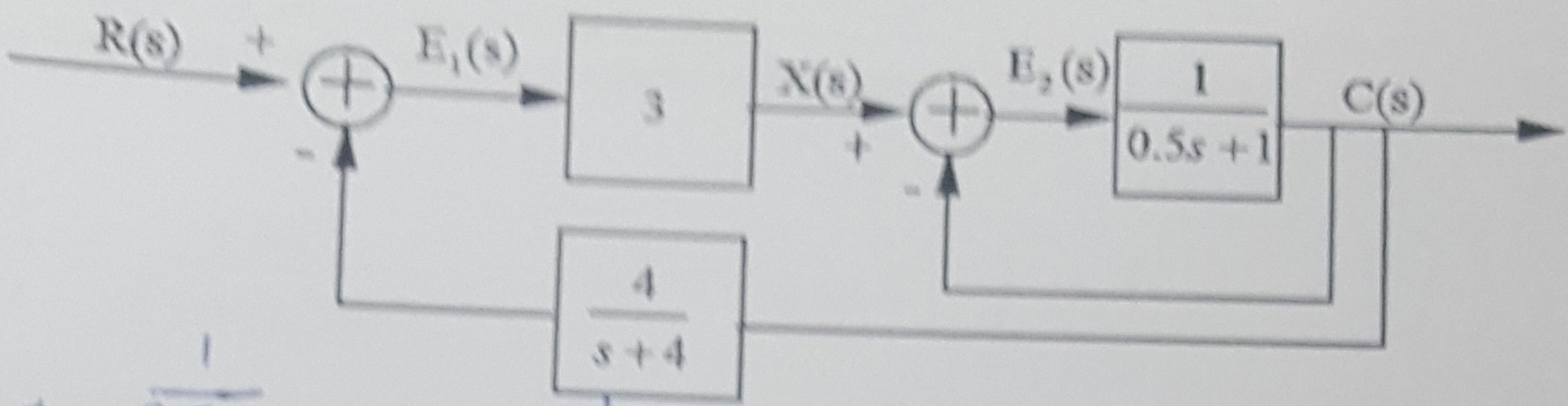
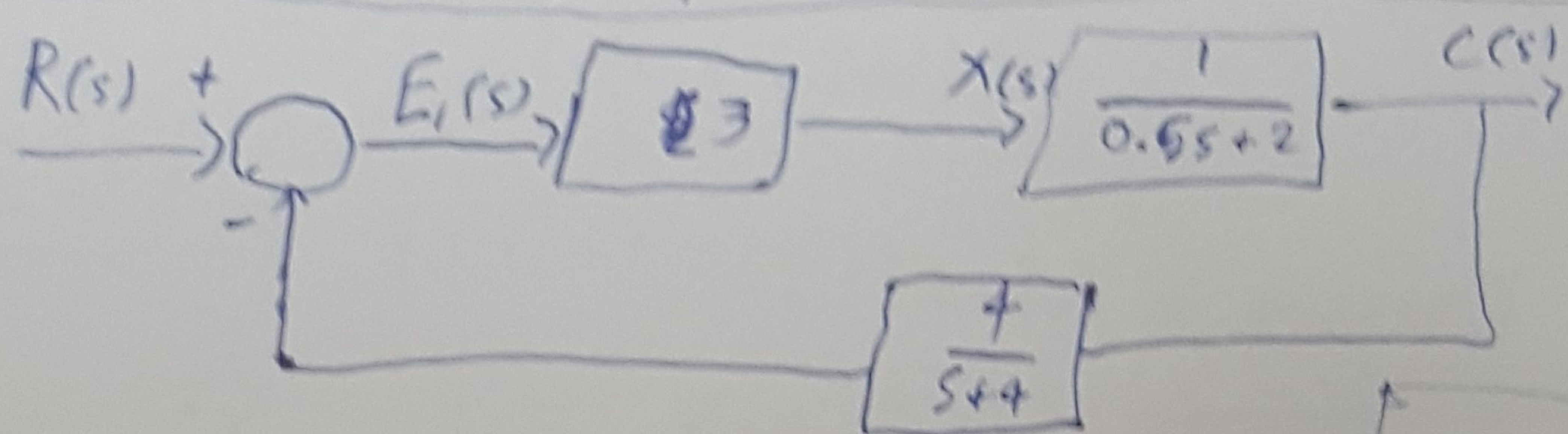
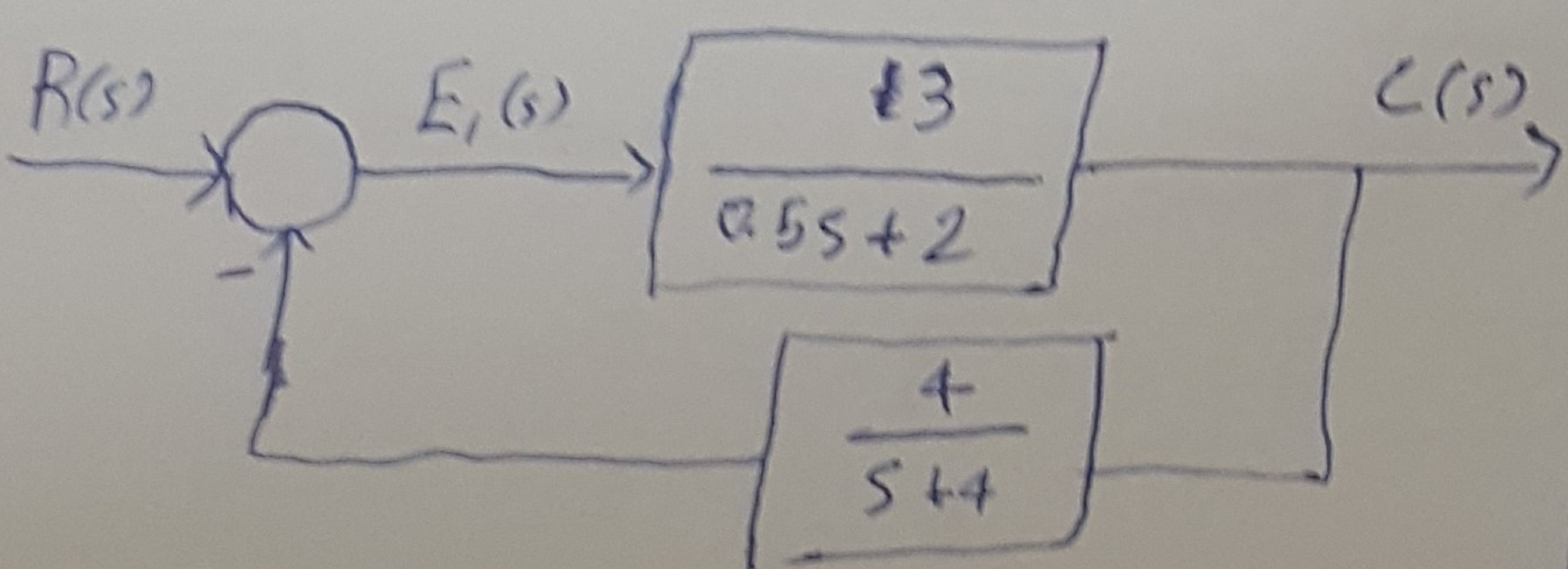


$$\frac{C(s)}{X(s)} = \frac{\frac{1}{0.5s+1}}{1+\frac{1}{0.5s+1}} = \frac{\frac{1}{0.5s+1}}{\frac{0.5s+1+1}{0.5s+1}} = \boxed{\frac{1}{0.5s+2}} = \frac{C(s)}{X(s)}$$ 5

$$\cancel{\frac{C(s)}{X(s)} = \frac{C(s)}{E_2(s)} = \frac{1}{0.5s+2}}$$

$$\boxed{\frac{C(s)}{E_2(s)} = \frac{1}{0.5s+1}}$$ 5





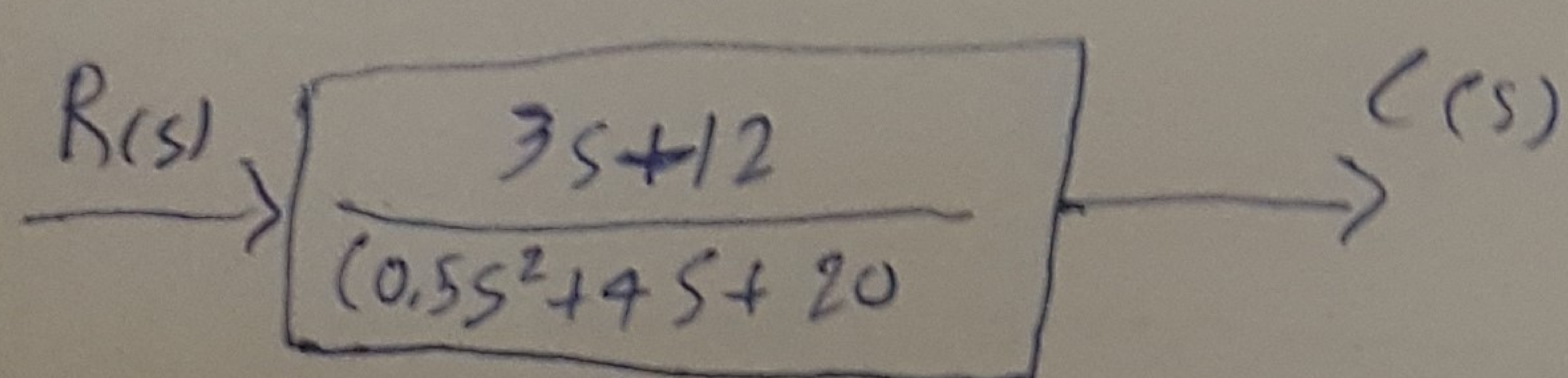
$$\frac{C(s)}{R(s)} = \frac{\frac{3}{0.5s+2}}{1+\frac{3}{0.5s+2}\cdot\frac{4}{s+4}}$$

$$= \frac{\frac{3}{0.5s+2}}{1+\frac{12}{(0.5s+2)(s+4)}}$$

$$= \frac{\frac{3}{(0.5s+2)}}{\frac{12+(0.5s+2)(s+4)}{(0.5s+2)(s+4)}}$$

$$= \frac{3(s+4)}{12+(0.5s+2)(s+4)}$$

$$= \frac{3s+12}{(0.5s^2+4s+8+12)}$$



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$$\frac{C(s)}{R(s)} = \boxed{\frac{3s+12}{(0.5s^2+4s+20)}}$$

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Question No. 3 Given the transfer function

$$G(s) = \frac{Y(s)}{U(s)} = \frac{4s+1}{s^2+3s+2}$$

a) What are the poles of this transfer function?
b) What is the impulse response associated with this transfer function (solve)?

a) $\frac{Y(s)}{U(s)} = \frac{4s+1}{(s+1)(s+2)} \Rightarrow$ Poles: [-1, -2]

b) PFE

$$\frac{4s+1}{(s+1)(s+2)} = \frac{A}{s+1} + \frac{B}{s+2}$$

$$\Rightarrow 4s+1 = (s+2)A + (s+1)B$$

$\boxed{s=-1} \Rightarrow 4(-1)+1 = (-1+2)A + \cancel{(-1+1)B}$

$\Rightarrow -3 = (1)A \Rightarrow \boxed{A=-3}$

$\boxed{s=-2} \Rightarrow 4(-2)+1 = \cancel{(-2+2)A} + (-2+1)B$

$\Rightarrow -7 = -B \Rightarrow \boxed{B=7}$

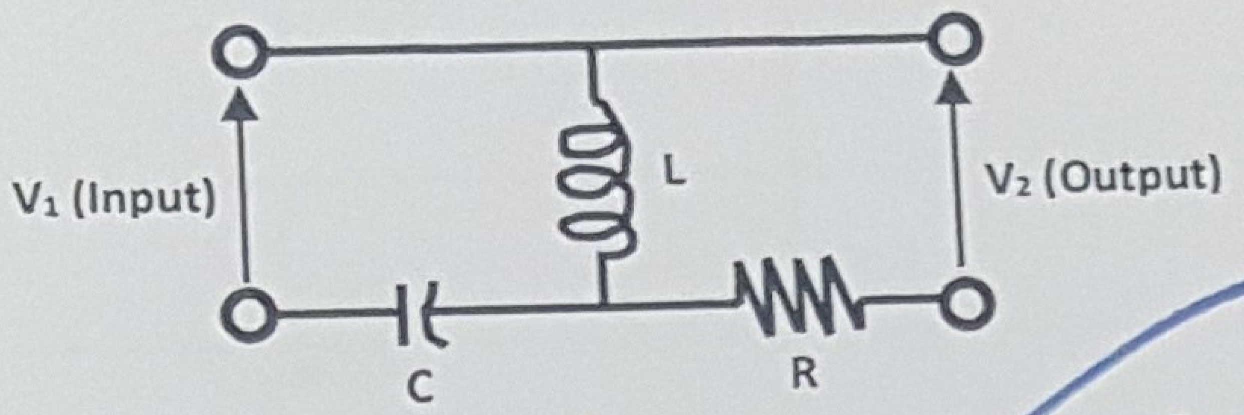
$$\Rightarrow \frac{Y(s)}{U(s)} = \frac{-3}{s+1} + \frac{7}{s+2}$$

$\mathcal{L}^{-1}[\ldots]$

$$\boxed{\frac{y(t)}{u(t)} = -3e^{-t} + 7e^{-2t}}$$

final value → Next Page

Question No. 4 Find the transfer function for the following models:



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$$V_1(s) = \frac{1I}{Cs} + LsI$$

$$V_1(s) = \frac{1}{Cs} + \frac{LsCs}{Cs} = \frac{1+LsCs}{Cs}$$

$$V_2(s) = R + Ls$$

$$TF = \frac{\text{output}}{\text{input}} = \frac{V_2(S)}{V_1(S)}$$

$$\frac{V_2(S)}{V_1(S)} = \frac{R+Ls}{\frac{1+LsCs}{Cs}} = \frac{Cs(R+Ls)}{1+LsCs}$$

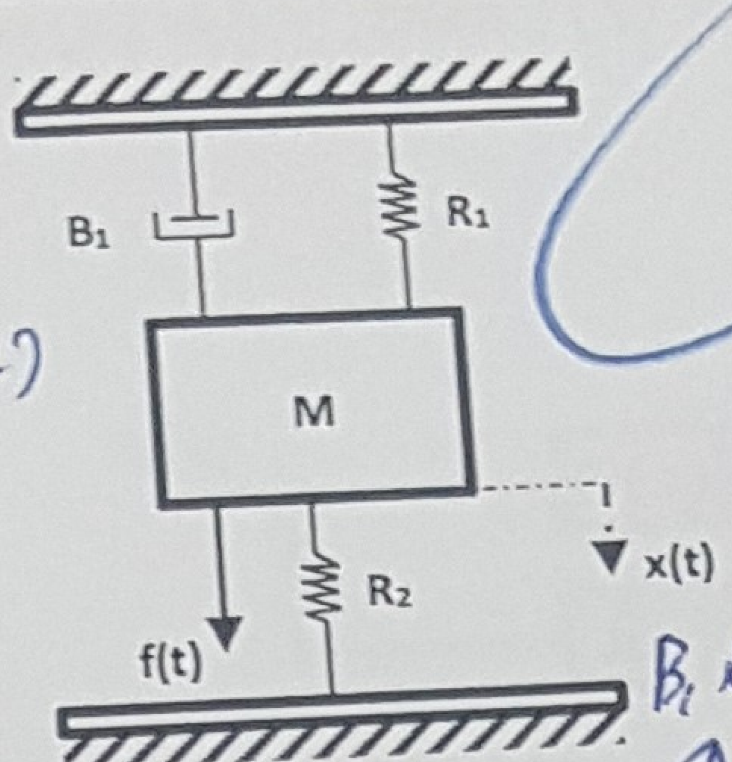
$$\boxed{\frac{V_2(s)}{V_2(s)} = \frac{RCs + LCs^2}{1+LCs^2}}$$

or

$$\boxed{TF = \frac{V_2(s)}{V_2(s)} = \frac{R+Ls}{\frac{1}{Cs}+Ls}}$$

input: $f(t)$

output: $x(t)$



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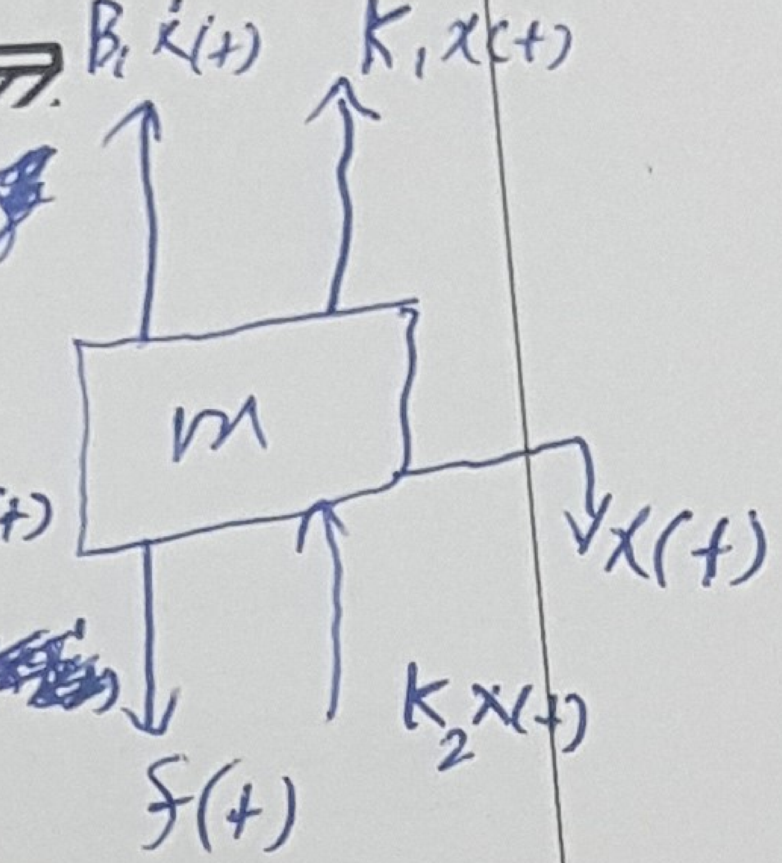
F.B.D



$$\sum F = ma$$

$$\Rightarrow m\ddot{x}(t) = f(t) - K_2 x(t) - B_1 \dot{x}(t) - K_1 x(t)$$

$$\mathcal{L}[\text{----}]$$

$$\Rightarrow Ms^2 X(s) = F(s) - K_2 X(s) - K_1 X(s) - B_1 s X(s)$$

$$(Ms^2 + B_1 s + K_1 + K_2)\, X(s) = F(s)$$

$$X(s) = \frac{1}{(Ms^2 + B_1 s + K_1 + K_2)} F(s)$$

$$\boxed{TF = \frac{X(s)}{F(s)} = \frac{1}{Ms^2 + B_1 s + K_1 + K_2}}$$

or

$$\boxed{TF = \frac{X(s)}{F(s)} = \frac{1}{Ms^2 + B_1 s + R_1 + R_2}}$$

Question No. 1 Choose the correct answer for the following

1. A control system in which the control action is somehow dependent on the output is known as (a) Closed loop system (b) Semi-closed loop system (c) Open system (d) None of the above	2. Control without measuring devices (sensors) are called .... control (a) PID (b) PI (c) closed –loop (d) open-loop
3. Non-linear terms in ODE's can be linearized using .... (a) Euler angles (b) an eraser (c) Taylor's series (d) force	4. The more time delay is, the more it is .... to control. (a) easy (b) stable (c) difficult (d) poles

Question No. 2 Choose the correct answer for the following

1. Find the Laplace Transform of the following function: 8 $\mathcal{L}\{e^{2t}(\sin 2t - 2)\}$ $\Rightarrow \mathcal{L}\left[e^{2t}\sin 2t - e^{2t}\cdot 2\right]$ $= \frac{2}{(s-2)^2+2^2} - \frac{2}{(s-2)}$	2. Find the Inverse Laplace Transform of the following function: 10 $\mathcal{L}^{-1}\left\{\frac{s+8}{s^2+4}\right\}$ $\Rightarrow \mathcal{L}^{-1}\left[\frac{s}{s^2+4} + \frac{8}{s^2+4}\right]$ $\Rightarrow \mathcal{L}^{-1}\left[\frac{s}{s^2+2^2} + \frac{2}{s^2+2^2}\cdot 4\right]$ $= \cos 2t + 4\sin 2t$