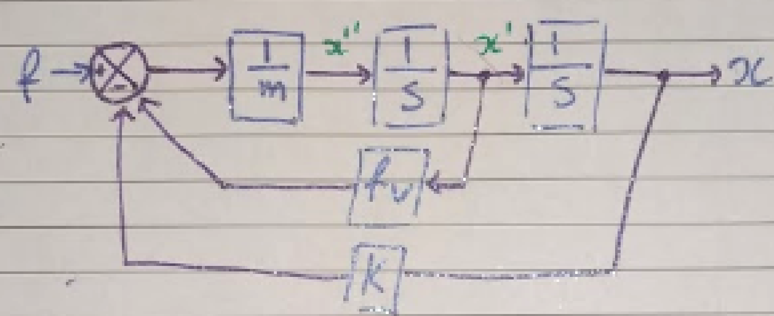
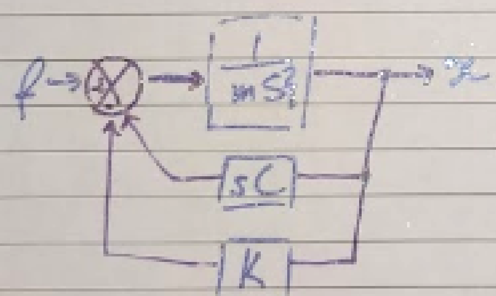
ECEN315 Test 1
Daniel Eisen 300447549

Ecen 321 Test Daniel Eisen 300447549

Q1. $F = \begin{matrix} ma \\ kx \\ f_v V \end{matrix}$, $f(t) = \begin{matrix} m\,x'' \\ k\,x' \\ f_v\,x'' \end{matrix}$

$$f = mx'' + f_v x' + kx' \Rightarrow \frac{1}{m}\left[f - f_v x' - kx\right] = x''$$





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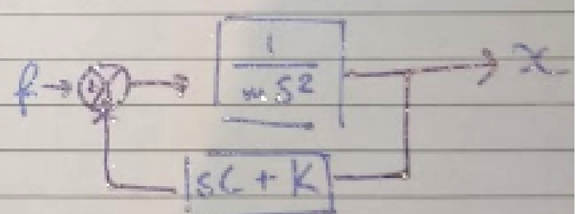

$$\Rightarrow \frac{\frac{1}{ms^2}}{1 + \frac{sc+K}{ms^2}} = \frac{1}{ms^2 + sc + k} = \frac{X(s)}{F(s)}$$

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Q2. I) $\frac{P}{V} = \frac{1/K}{s(1+sT)}$ $K = 0.2$, $T = 0.8$

$$\frac{P}{R} = \frac{\frac{c/k}{s(1+sT)}}{1 + \frac{c/k}{s(1+sT)}}$$

$$= \frac{c/k}{s(1+sT) + c/k} \Rightarrow \frac{c/k}{Ts^2 + s + \frac{c}{k}} = \frac{P}{R}$$

II) char: $Ts^2 + s + \frac{c}{k} = 0$

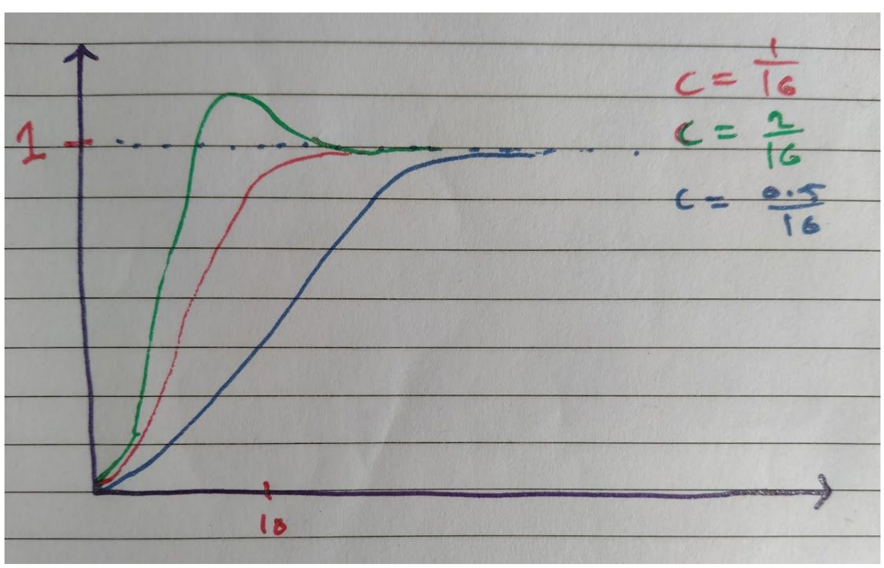
critically: $b^2 - 4ac = 0$

$1 - 4T\frac{c}{k} = 0$

$c = \frac{k}{4T} = \frac{1}{16}$

$\therefore$ under: $c > \frac{1}{16}$

over: $c < \frac{1}{16}$



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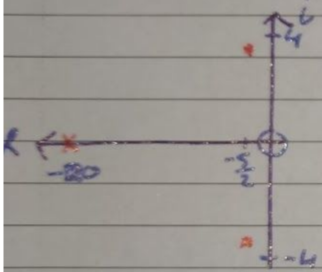
Q3 I) $G(s) = \dfrac{1}{(s+20)(s^2+5s+20)}$

$p_1 = -20$, $p_{2,3} \Rightarrow$ quadratic equation

$= -\frac{5}{2} \pm 3.7$



II) Can approx as second order by discarding the fastest pole and compensate for the change in SSG

↳ $\frac{1}{20} \cdot \frac{1}{s^2+5s+20}$

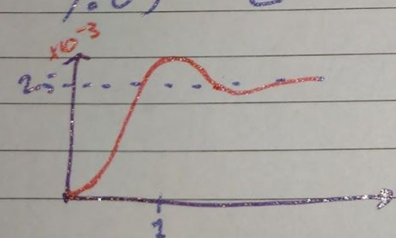
III) $\omega_n = \sqrt{20} \approx 4.4721$

$\zeta = \dfrac{5/2}{\sqrt{20}} \approx 0.559$

$T_p = \dfrac{\pi}{\sqrt{20}(\sqrt{1-0.559^2})} = 0.847$

$T_s = \dfrac{4}{0.559 \cdot 4.472} \approx 1.6$

$\%OS = e^{-(\zeta\pi/\sqrt{1-\zeta^2})} \approx 0.12 \rightarrow 12\%$



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Q4 I) Negative feedback: When the output signal is subtracted from the input signal and fed back into system

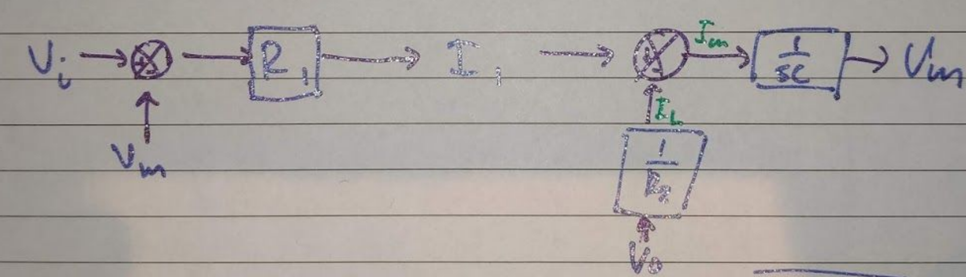
II) Reduces noise, the effects of disturbances & the sensitivity to external change

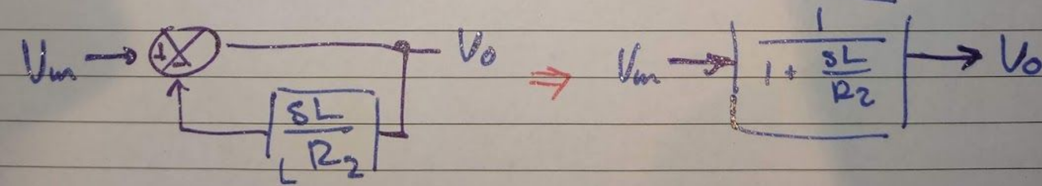
III) · In audio, ie. distortion effects
· Cooling, in exothermic reactions.

Q5. $V_i - V_m = R_1 I_1$ $\quad$ $V_m - V_o = sLI_L$

$I_m = I_1 - I_L$ $\quad$ $I_L = \frac{V_o}{R_2}$

$V_m = \frac{1}{sC} I_m$ $\quad$ $\therefore V_m - \frac{sL}{R_2} V_o = V_o$





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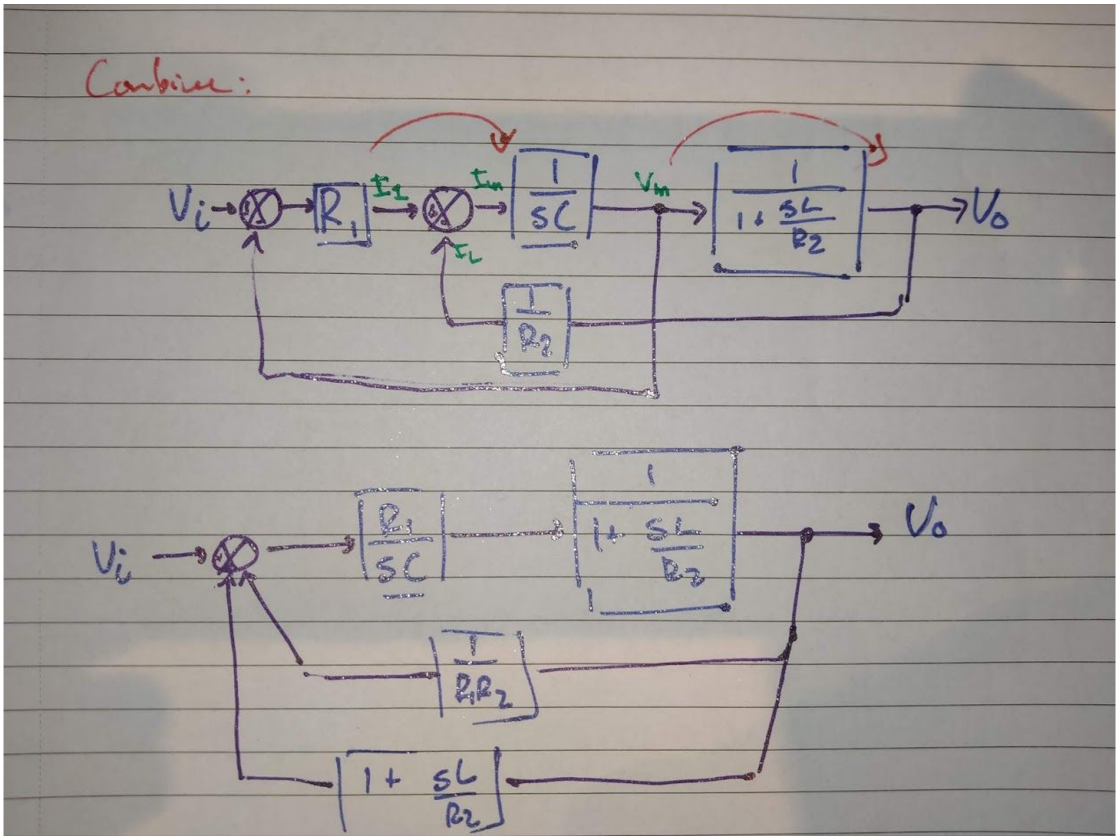
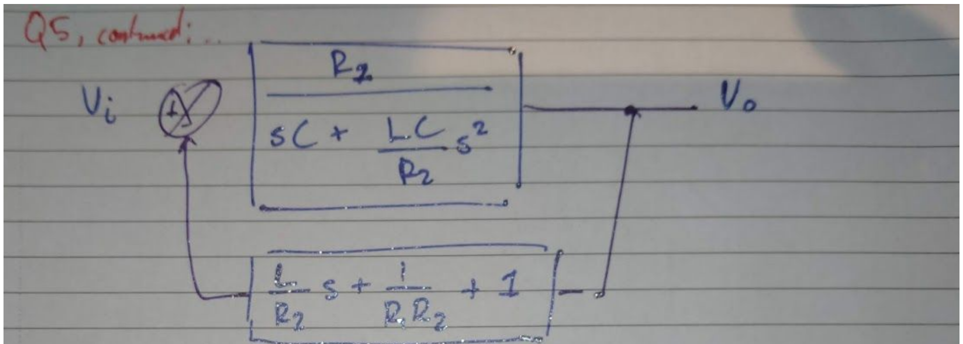


Q5, continued:



$$\Rightarrow \frac{\dfrac{R_1}{\cancel{\frac{LC}{R_2}s^2 + Cs}}}{1 + \left(\dfrac{L}{R_2}s + \dfrac{1}{R_1R_2} + 1\right)\left(\dfrac{R_1}{\cancel{\frac{LC}{R_2}s^2 + Cs}}\right)}$$

$$= \frac{R_1}{\dfrac{LC}{R_2}s^2 + Cs + \dfrac{LR_1}{R_2}s + \dfrac{1}{R_2} + R_1}$$

$$= \frac{R_1}{\frac{LC}{R_2}s^2 + Cs + \frac{LR_1}{R_2}s + \frac{1}{R_2} + R_1}$$

$$= \frac{1}{\underbrace{\frac{LC}{R_1R_2}}_{a}s^2 + \underbrace{\left(\frac{C}{R_1} + \frac{L}{R_2}\right)}_{b}s + \underbrace{\frac{1}{R_1R_2} + 1}_{c}}$$

Both C & L do not contribute to steady state gain so altering either can effect damping without changing SSG.

ie: $b^2 - 4ac$: $L = 1 \Rightarrow -32$ $\therefore$ underdamped