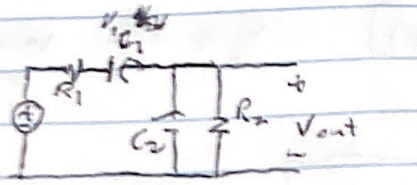
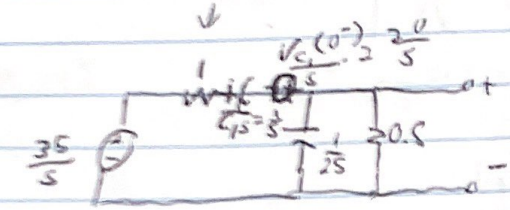
4.3)

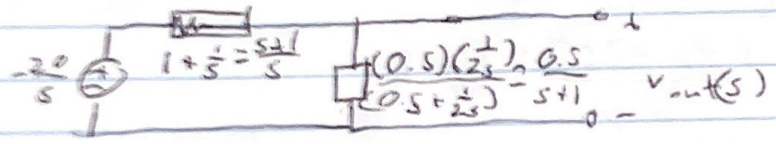


$V_s(t) = 35u(t)$ V

$V_{C_1}(0^-) = 20$V $R_1 = 1\Omega$ $C_1 = 1$F

$R_2 = 0.5\Omega$ $C_2 = 2$F





$$V_{out}(s) = \frac{15}{s} \cdot \left(\frac{0.5}{s+1}\right) \Big/ \left(\frac{s+1}{s} + \frac{0.5}{s+1}\right)$$

$$= \frac{15}{s} \cdot \frac{0.5s}{(s+1)^2 + 0.5s} = \frac{7.5}{s^2 + 0.5s + 2s + 1}$$

$$= \frac{7.5}{(s+2)(s+0.5)}$$

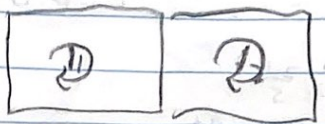
$$V_{out}(s) = \frac{A}{s+2} + \frac{B}{s+0.5}$$

$$A = (s+2)\,V_{out}(s)\Big|_{s\to -2} = \frac{7.5}{-2+0.5} = -5$$

$$B = (s+0.5)\,V_{out}(s)\Big|_{s\to -0.5} = \frac{7.5}{-0.5+2} = 5$$

$$\boxed{v_{out}(t) = 5\left(e^{-0.5t} - e^{-2t}\right)u(t)\ \text{V}}$$

4.12 $V_s(s) = \mathcal{L}[10 - 5u(t)] = 10 - \frac{5}{s}$ $\quad X_c = \frac{2}{s}$ $\quad X_L = 2s$



eq.1: $10 - \frac{5}{s} = I_1 + \left(\frac{2}{s}\right)(I_1 - I_2)$

eq.2: $3I_2 + 2sI_2 + \left(\frac{2}{s}\right)(I_2 - I_1) = 0$

$3I_2 + 2sI_2 + \frac{2I_2}{s} = \frac{2I_1}{s}$

$I_1 = \left(\frac{3s^2 + 2s^2 + 2}{2}\right) I_2$

substitute

$10 - \frac{5}{s} = \left(\frac{3s+2s^2+2}{2}\right) I_2 + \frac{2}{s}\left(\left(\frac{3s+2s^2+2}{2}\right) I_2 + I_2\right)$

$10 - \frac{5}{s} = I_2\left(\frac{3s^2+2s^3+2s+6s+4s^2+4-2s}{2}\right)$

$I_2 = 2(10s-5)/(2s^3+7s^2+8s)$

$I_2 = I_L = \frac{10s-5}{s(s+1.75-j0.9682)(s+1.75+j0.9682)}$

$I_L = \frac{A_1}{s} + \frac{B_1}{s+1.75-j0.9682} + \frac{B_2}{s+1.75+j0.9682}$

$A_1 = sI_L\big|_{s=0} = -\frac{5}{4}$ $\quad B_1 = (s+1.75-6.9682)\, I_L\big|_{s=-1.75+j0.9682}$

$= 6.294 + j0.625$

$B_2 = 6.294 - j0.625$

$i_L(t) = \mathcal{L}^{-1}\left(-\frac{5}{4s} + \frac{6.294+j0.625}{s+1.75-j0.9682} + \frac{6.294-j0.625}{s+1.75+j0.9682}\right)$

$=$

$i_L(t) = -\frac{5}{4}u(t) + 6.325\left(2\cos(0.9682t + 5.67^\circ)\right) e^{-1.75t} u(t)$

$=$

4.16 $v_s(t) = 10[u(t) - u(t-5)]$ V

$V_s(s) = 10\left(\frac{1-e^{-5s}}{s}\right)$

same mesh as ex. 4.12

$10\left(\frac{1-e^{-5s}}{s}\right) - I_1 - \left(\frac{2}{s}\right)(I_1 - I_2) = 0$

$(s+2)I_1 - 2I_2 = 10(1-e^{-5s})$

$3I_2 + 2sI_2 + \left(\frac{2}{s}\right)(I_2 - I_1) = 0$

$I_1 = \left[\frac{3s+2s^2+2}{2}\right] I_2$

$I_2 = I_L = \frac{20(1-e^{-5s})}{s(2s^2+7s+8)}$

$I_L = \frac{20(1-e^{-5s})}{s(s+1.75-j0.9682)(s+1.75+j0.9682)}$

$i_L(t) = \mathcal{L}^{-1}[I_L] =$

$20\,u(t-5)e^{-7(t-5)/4}\cos(15^{1/2}(t-5)/4)$

$+ 7\cdot 15^{1/2}\sin(\cos^{-1}(t-5)/4)/15)/8 - 1/8)$

$- 5e^{-7t/4}\cos(15^{1/2}t/4)/4$

$+(7\cdot 15^{1/2}\sin(15^{1/2}t/4)/15)/2 + 5/2$

matlab

4.19 $i_s(t) = [1.5u(-t) + (1 + 0.5\cos 4t)u(t)]$

$i_L(0^-) = \left(\frac{R_1}{R_1+R_2}\right) i_s(0^-) = 1A$

$i_L(0^+) = i_L(0^-)$ $i_s(t)$ for $t \geq 0 = (1+0.5\cos 4t)A$

$I_s = \mathcal{L}[i_s(t)] = \frac{1}{s} + \frac{0.5s}{s^2+16}$

$\frac{(I_2 - I_1)}{2} + \frac{5I_2}{2} - 0.5 + 0.5I_2 = 0$

$(1 + 0.5s + 0.5)I_2 - I_1 = 0.5$

$(1.5 + 0.5s)I_2 + \left(\frac{1}{s} + \frac{0.5s}{s^2+16}\right) = \frac{1}{2}$

$I_2 = (1.5+0.5s)I_2 = \frac{2(s^2+16+0.5s^2) + 5(s^2+16)}{2s(s^2+16)}$

$$I_2 = \frac{2s^2+3)+s^2+s^3+16s}{2s(s^2+16)(1.5+0.5s)}$$

$$= \frac{s^3+3s^2+16s+32}{s(s^2+16)(s+3)}$$

$$V_{out} = R_2 I_2$$

$$= \frac{s^3+3s^2+16s+32}{2s(s+3)(s+j4)(s-j4)}$$

ilaplace (s^3+3.s^2+16.s+32) / ((2.s.(s+3).(s+j.4).(s-j.4))

$$v_{out}(t) = \frac{8e^{-3t}}{75} + e^{-t4i}\left(\frac{3}{100}+\frac{i}{25}\right) + e^{t4i}\left(\frac{3}{100}-\frac{i}{25}\right)$$

4.31 $$\frac{0-V_s}{R_1+\frac{1}{sC}} = \frac{V_s-V_o}{R_2}$$

$$V_s\left[\frac{1}{R_2}+\frac{1}{R_1+\frac{1}{sC}}\right] = \frac{V_o}{R_2}$$

$$V_s\left[\frac{1}{R_2}+\frac{sC}{s(R_1+1)}\right] = \frac{V_o}{R_2}$$

$$V_s\left[\frac{sCR_1+1+sCR_2}{R_2C_s(R_1+1)}\right] = \frac{V_o}{R_2}$$

$$\frac{V_o}{V_s} = \frac{(sCR_1+1)+sCR_2)}{sCR_1+1}$$

$$= 1+\frac{sCR_2}{(sCR_1+1)}$$

$$= 1+\frac{sCR_2}{CR_1(s+\frac{1}{CR_1})}$$

$$= 1+\frac{R_2}{R_1}\left(\frac{s}{s+\frac{1}{CR_1}}\right) = H(s)$$

$$H(s) = 1+4\cdot10^6\left(\frac{s}{s+1000}\right)$$

$$h(t) = \delta(t)+4\cdot10^6\left[(1000e^{-1000t})u(t)+1\right]$$

4.36 $H(s) = \frac{3s^2+4s+5}{s^2+6s+7}$

$= \left(\frac{3s^2+4s+5}{s^2}\right)\left(\frac{s^2+6s+7}{s^2}\right)^{-1}$

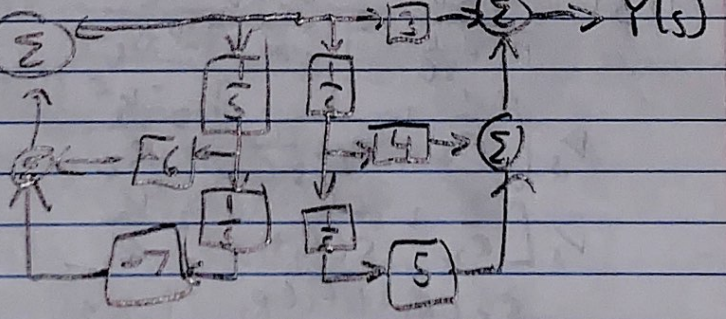
$= \left(3+\frac{4}{s}+\frac{5}{s^2}\right)\left(\frac{1}{1+\frac{6}{s}+\frac{7}{s^2}}\right)$

$H(s) = H_1(s)H_2(s)$

$H_1(s) = \left(3+\frac{4}{s}+\frac{5}{s^2}\right) \quad H_2(s) = \left(1+\frac{6}{s}+\frac{7}{s^2}\right)^{-1}$

$Z_2(s) = H_2(s)X(s) = \left(1+\frac{6}{s}+\frac{7}{s^2}\right)^{-1}X(s)$

$Y(s) = H_1(s)Z_2(s) = \left(3+\frac{4}{s}+\frac{5}{s^2}\right)Z_2(s)$



4.41 $h(t) = e^{t}u(t) - e^{-5t}u(t)$

$H(s) = \frac{1}{s-1} - \frac{1}{s+5}$

$= \frac{(s+5)-(s-1)}{(s-1)(s+5)}6 = \frac{6}{(s-1)(s+5)}$

$Q(s) = \frac{H(s)}{1+6(s)H(s)} = \frac{H(s)}{1+kH(s)} = \left(\frac{6}{(s-1)(s+5)}\right)\left(\frac{1}{1+k\left[\frac{6}{(s-1)(s+5)}\right]}\right)$

$= \frac{6}{(s-1)(s+5)+6k}$

$Q(s) = \frac{6}{s^2+4s-5+6k} \qquad s^2+4s-5+2k=0$

poles $\{-1, -3\}$

$(s+1)(s+3) = 0 \quad s^2+3s+s+3 = 0 \quad s^2+4s+3 = 0$

$s^2+4s+3 = s^2+4s-5+6k \quad \boxed{k = \frac{1}{2}}$

1) $s^2 + 2\varepsilon\omega_0 s + \omega_0^2 \quad \omega_0 = \sqrt{6k-5} \quad 2\varepsilon\omega_0 = 4$

$\boxed{k = 1.5}$