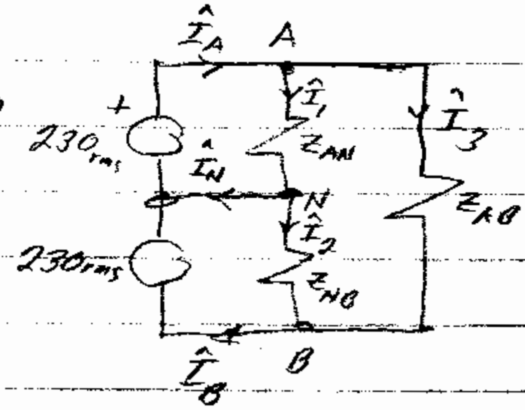
EE 212 Homework 1

12.10



$$\hat{S} = \hat{V}_{rms}\, \hat{I}_{rms}^{\,*}$$

$$\therefore\ \hat{I}_1 = \left(\frac{\hat{S}_{AN}}{230}\right)^* = \frac{10{,}000\, e^{-j40^\circ}}{230} = 43.478\, e^{-j40^\circ}$$

$$\hat{I}_2 = \left(\frac{\hat{S}_{NB}}{230}\right)^* = \frac{8\times10^3 e^{-j10^\circ}}{230} = 34.78\, e^{-j10^\circ}$$

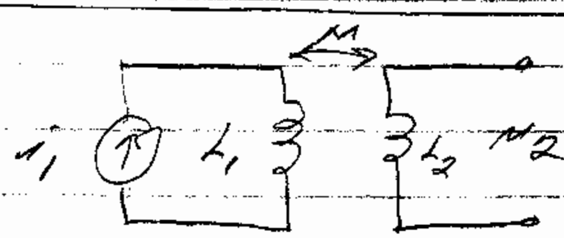
$$\hat{I}_3 = \left(\frac{\hat{S}_{AB}}{230}\right)^* = \frac{4\times10^3 e^{j80^\circ}}{460} = 8.696\, e^{j80^\circ}$$

$$\hat{I}_A = \hat{I}_1 + \hat{I}_3 = 34.816 - j19.383 = \boxed{39.85\, e^{-j29^\circ}} \leftarrow$$

$$\hat{I}_B = \hat{I}_2 + \hat{I}_3 = 35.76 + j2.52 = \boxed{35.85\, e^{j4^\circ}} \leftarrow$$

$$\hat{I}_N = \hat{I}_1 - \hat{I}_2 = -0.946 - j21.91 = \boxed{-21.98\, e^{j87.53^\circ}} \leftarrow$$

13.1



$i_1(t) = 400\cos 120\pi t$

$v_2(t) = 100\cos(120\pi t + \theta)$

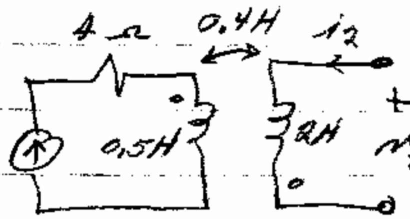
but $v_2 = \pm M \dfrac{di}{dt} = \pm M\, 400\times 120\pi\,(-\sin 120\pi t)$

$$\text{so } M = \frac{100}{400\times 120\pi} = 0.663\ \text{mH}$$

EE 211 Homework 2

12.8 a)

ck sign

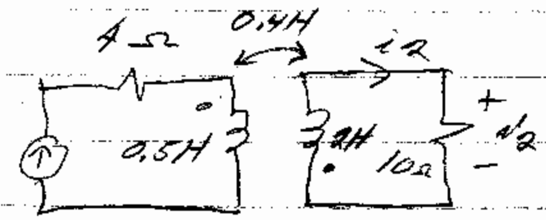


$$v_2 = 2\frac{di_2}{dt} - 0.4\frac{d}{dt}(\cos 100\pi t)$$ with $i_2 = 0$

$$\boxed{v_2 = 40\pi \sin 100\pi t}$$

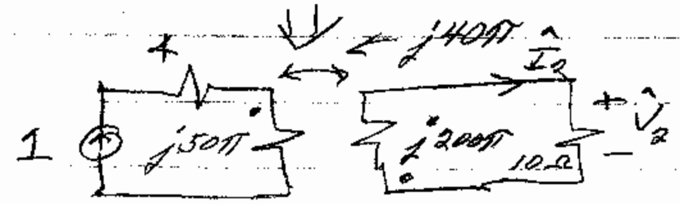
or $v_2 = 40\pi\cos(100\pi t - 90^\circ)$

b)



$$v_2 = -2\frac{di_2}{dt} + 0.4\frac{d}{dt}(\cos 100\pi t)$$

$$v_2 = +10\, i_2$$

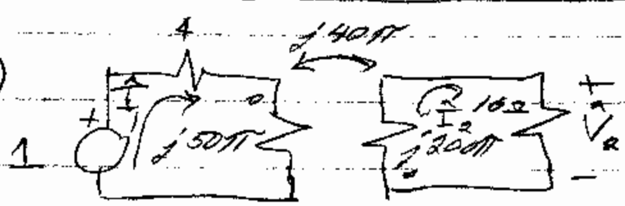


$$\hat{I}_2\, j200\pi + j40\pi \times 1 + 10\hat{I}_2 = 0\ ;\ \hat{I}_2 = \frac{-j40\pi}{10 + j200\pi}$$

$$\hat{V}_2 = 10\hat{I}_2 = \frac{-j400\pi}{10 + j200\pi} = \frac{-j2}{\frac{1}{20\pi} + j} = \frac{2e^{-j90^\circ}}{1\, e^{j89.09^\circ}} = 2e^{-j179.09^\circ}$$

or $\boxed{v_2(t) = 2\cos(100\pi t - 179.09^\circ)}$

c)



$$4\hat{I}_1 + j50\pi\hat{I}_1 + j40\pi\hat{I}_2 = 1$$

$$j200\pi\hat{I}_2 + j40\pi\hat{I}_1 + 10\hat{I}_2 = 0$$

or

$$\hat{I}_1(4 + j50\pi) + j40\pi\hat{I}_2 = 1 \qquad (1)$$

$$j40\pi\hat{I}_1 + (10 + j200\pi)\hat{I}_2 = 0 \qquad (2)$$

$$\hat{I}_2 = \frac{\begin{vmatrix} 4+j50\pi & 1 \\ j40\pi & 0 \end{vmatrix}}{\begin{vmatrix} 4+j50\pi & j40\pi \\ j40\pi & 10+j200\pi \end{vmatrix}} = \frac{-j40\pi}{40 - 10{,}000\pi^2 + j(500\pi + 800\pi) + 1600\pi^2}$$

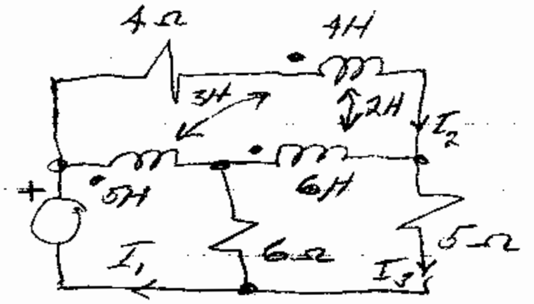
$$\text{or } \hat{V}_2 = 10\hat{I}_2 = \frac{10 \times 40\pi\, e^{-j90^\circ}}{-82{,}864.7 + j4084} = \frac{1{,}256.6\, e^{-j90^\circ}}{82{,}965\, e^{j177.18^\circ}} = 0.015\, e^{-j267.18}$$

$$\boxed{v_2(t) = 0.015\cos(100\pi t + 92.82^\circ)}$$

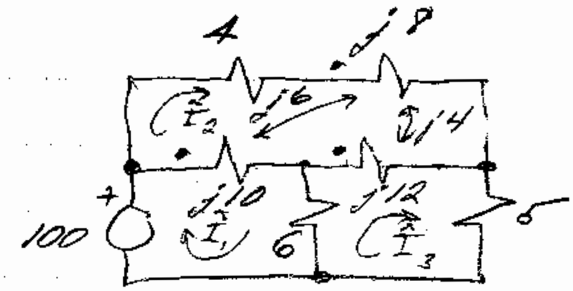
EE 212 Homework 3

13.15

$100\cos 2t$



$\Rightarrow$



$$100 = (\hat{I}_1 - \hat{I}_2) j10 + j6\hat{I}_2 + (\hat{I}_1 - \hat{I}_3)6$$

$$0 = 4\hat{I}_2 + j8\hat{I}_2 + (\hat{I}_1 - \hat{I}_2) j6 + (\hat{I}_3 - \hat{I}_2) j4 + (\hat{I}_2 - \hat{I}_3) j12$$
$$- \hat{I}_2 j4 + (\hat{I}_2 - \hat{I}_1) j10 - j6\hat{I}_2 = 0$$

$$0 = (\hat{I}_3 - \hat{I}_1)6 + (\hat{I}_3 - \hat{I}_2) j12 + \hat{I}_2 j4 + 5\hat{I}_3 = 0$$

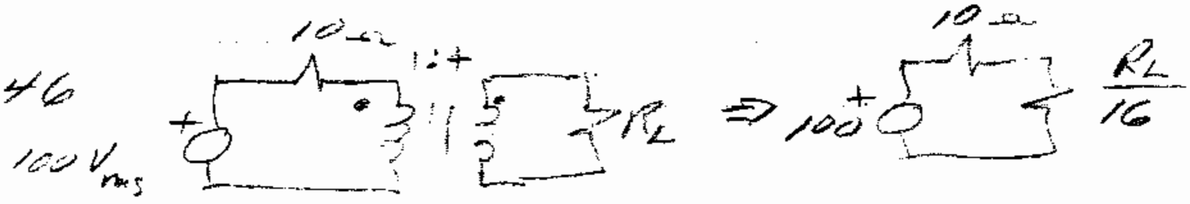
or
$$\left[\begin{aligned} &\hat{I}_1(6+j10) + \hat{I}_2(-j4) - \hat{I}_3 6 = 100 \\ &\hat{I}_1(-j4) + \hat{I}_2(4+j10) + \hat{I}_3(-j8) = 0 \\ &-6\hat{I}_1 + \hat{I}_2(-j8) + \hat{I}_3(11+j12) = 0 \end{aligned}\right]$$

from computer

$$\boxed{\hat{I}_3 = 4.32 e^{-j\,54.3^\circ}}$$

EE 212 Homework 4

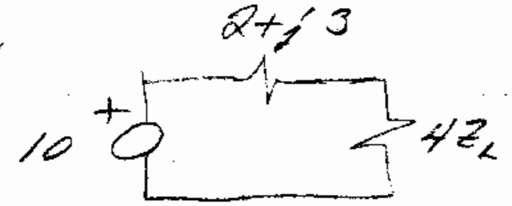
13,46



for maximum power $\frac{R_L}{16} = 10$ or $\boxed{R_L = 160\,\Omega}$

$$P_{max} = \frac{50^2}{10} = \frac{2500}{10} = \boxed{250\text{ Watts}}$$

Special

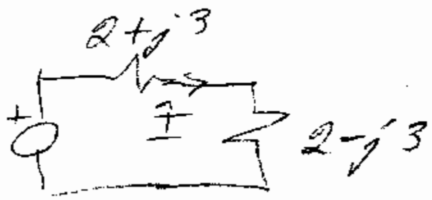


for maximum power transfer

$4Z_L = 2-j3$

a) or $\boxed{Z_L = \frac{2-j3}{4}}$

b)



$$\hat{I} = \frac{10}{4}$$

$$P_{max} = |\hat{I}|^2 \times 2 = \frac{100}{16} \times 2$$

$$\boxed{P_{max} = \frac{25}{2}\text{ Watts}}$$

EE 212 Homework 5

14.18 a) $\mathcal{L}\{3u(t)\} = \int_{0^-}^{\infty} 3e^{-st}\,dt = -\frac{3}{s}e^{-st}\Big|_0^{\infty} = \boxed{\frac{3}{s}}$

b) $\mathcal{L}\{3u(t-3)\} = \int_{0^-}^{\infty} 3u(t-3)e^{-st}\,dt = \int_{3}^{\infty} 3e^{-st}\,dt$

$= \frac{-3}{s}e^{-st}\Big|_3^{\infty} = \boxed{\frac{3}{s}e^{-3s}}$

c) $\mathcal{L}\{3u(t-3)-3\} = \frac{3}{s}e^{-3s} - \frac{3}{s} = \frac{3}{s}\left[e^{-3s}-1\right]$

[using parts a) and b)]

d) $\mathcal{L}\{3u(3-t)\} = \int_{0^-}^{\infty} 3u(3-t)e^{-st}\,dt = \int_{0}^{3} 3e^{-st}\,dt$

$= -\frac{3}{s}e^{-st}\Big|_0^3 = +\frac{3}{s}\left[1-e^{-3s}\right]$

14.19

a) $\mathcal{L}\{2+3u(t)\} = \boxed{\frac{5}{s}}$ from a) above

b) $\mathcal{L}\{3e^{-8t}\} = \int_{0^-}^{\infty} 3e^{-8t}e^{-st}\,dt = 3\left[\frac{-1}{s+8}\right]e^{-st}\Big|_0^{\infty}$

$\boxed{= \frac{3}{s+8}}$

c) $\mathcal{L}\{u(-t)\} = \int_0^{\infty} 0 \times e^{-st}\,dt = \boxed{0}$

d) $\mathcal{L}\{K\} = \int_{0^-}^{\infty} Ke^{-st}\,dt = K\left(\frac{-1}{s}\right)e^{-st}\Big|_0^{\infty} = \boxed{\frac{K}{s}}$

EE 212 Homework 6

14.25 a) $F(s) = \frac{1}{s+3} \therefore f(t) = e^{-3t}u(t)$

b) $F(s) = 1 \therefore f(t) = \boxed{\delta(t)}$

c) $F(s) = \frac{1}{s^2} \therefore f(t) = \boxed{t u(t)}$

d) $F(s) = 275 \therefore f(t) = 275\,\delta(t)$

e) $F(s) = \frac{s^2}{s^3} = \frac{1}{s} \therefore f(t) = u(t)$

EE 212 Homework 7

14.32 a) $F(s) = 3 + \frac{1}{s} \Rightarrow f(t) = \boxed{3\delta(t) + u(t)}$

b) $F(s) = 3 + \frac{1}{s^2} \Rightarrow f(t) = 3\delta(t) + t\,u(t)$

c) $F(s) = \frac{1}{(s+3)(s+4)} = \frac{1}{s+3} + \frac{-1}{s+4} \Rightarrow f(t) = \{e^{-3t} - e^{-4t}\}u(t)$

d) $F(s) = \frac{1}{(s+3)(s+4)(s+5)} = \frac{1/2}{s+3} + \frac{-1}{s+4} + \frac{1/2}{s+5}$

$\therefore\ f(t) = \{\frac{1}{2}e^{-3t} - e^{-4t} + \frac{1}{2}e^{-5t}\}u(t)$

14.35 $V(s) = \frac{5}{s}$ so $v(t) = 5u(t)$

$i_{2K\Omega} = \frac{v}{2\times10^3} = \frac{5}{2\times10^3}u(t)$

so $\boxed{i_{2K\Omega} = \frac{5}{2}\times10^{-3} \text{ for all } t > 0\ !}$

EE 212 Homework 8

14.39 a) $F(s) = \frac{5}{s+1}$; $f(t) = \boxed{5e^{-t}u(t)}$

b) $F(s) = \frac{5}{s+1} - \frac{2}{s+4}$; $f(t) = \boxed{(5e^{-t} - 2e^{-4t})u(t)}$

c) $F(s) = \frac{18}{(s+1)(s+4)} = \frac{6}{s+1} + \frac{-6}{s+4}$; $\boxed{f(t) = (6e^{-t} - 6e^{-4t})u(t)}$

d) $F(s) = \frac{18s}{(s+1)(s+4)} = \frac{-6}{s+1} + \frac{24}{s+4}$; $\boxed{f(t) = (-6e^{-t} + 24e^{-4t})u(t)}$

e) $F(s) = \frac{18s^2}{(s+1)(s+4)} = \frac{18s^2}{s^2+5s+4} = 18 - \frac{90s+72}{(s+1)(s+4)}$

$$\left\{ \begin{array}{r} 18 \\ s^2+5s+4 \,\overline{)\, 18s^2} \\ 18s^2+90s+72 \end{array} \right\}$$

$F(s) = 18 - \frac{-6}{s+1} - \frac{96}{s+4}$; $f(t) = \boxed{18\delta(t) + (6e^{-t} - 96e^{-4t})u(t)}$

14.43 a) $F(s) = \frac{(s+1)(s+2)}{s(s+3)} = \frac{s^2+3s+2}{s^2+3s} = 1 + \frac{2}{s(s+3)}$

$$\left\{ \begin{array}{r} 1 \\ s^2+3s \,\overline{)\, s^2+3s+2} \\ s^2+3s \end{array} \right\}$$

$F(s) = 1 + \frac{\frac{2}{3}}{s} + \frac{-\frac{2}{3}}{s+3}$

$\boxed{f(t) = \delta(t) + \frac{2}{3}(1 - e^{-3t})u(t)}$

b) $F(s) = \frac{s+2}{s^2(s^2+4)} = \frac{As+B}{s^2} + \frac{Cs+D}{s^2+4}$

$B = \frac{1}{2}$; $s+2 = (As+\frac{1}{2})(s^2+4) + (Cs+D)s^2$

s^3 terms: $0 = A + C \Rightarrow C = -\frac{1}{4}$

s^2 terms: $0 = \frac{1}{2} + D \Rightarrow D = -\frac{1}{2}$

s terms: $1 = 4A \Rightarrow A = \frac{1}{4}$

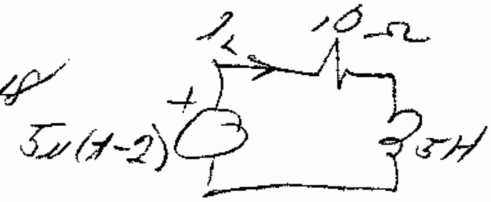
constant terms: $2 = 2$ ✓

$F(s) = \frac{\frac{1}{4}s + \frac{1}{2}}{s^2} + \frac{-\frac{1}{4}s - \frac{1}{2}\cdot\frac{2}{2}}{s^2+4}$

$\boxed{f(t) = \frac{1}{4}u(t) + \frac{1}{2}t\,u(t) - \left(\frac{1}{4}\cos 2t + \frac{1}{4}\sin 2t\right)u(t)}$

EE 212 Homework 9

14.48



$i_L(0) = 5\times10^{-3}$

a) $\boxed{5u(t-2) = 10 i_L + 5\frac{di_L}{dt}}$

b) $$\frac{5e^{-2s}}{s} = 10\,I(s) + 5\left\{s\,I(s) - 5\times10^{-3}\right\}$$

$$\therefore\ I(s) = \frac{\frac{5e^{-2s}}{s} + 25\times10^{-3}}{5s+10} = \frac{5e^{-2s} + 25\times10^{-3}s}{5s(s+2)}$$

$$\text{or}\quad I(s) = \frac{e^{-2s} + 5\times10^{-3}s}{s(s+2)} = \frac{e^{-2s}}{s(s+2)} + \frac{5\times10^{-3}}{s+2}$$

$$\boxed{I(s) = e^{-2s}\left[\frac{\frac{1}{2}}{s} + \frac{-\frac{1}{2}}{s+2}\right] + \frac{5\times10^{-3}}{s+2}}$$

c) $$\boxed{i_L(t) = \tfrac{1}{2}u(t-2) - \tfrac{1}{2}e^{-2(t-2)}u(t-2) + 5\times10^{-3}e^{-2t}u(t)}$$

Special

$$F(s) = \frac{-5s^2-30s+15}{s^3+2s^2+5s} = \frac{-5s^2-30s+15}{s(s^2+2s+5)} = \frac{A}{s} + \frac{Bs+C}{s^2+2s+5}$$

$A = 3$ $\quad\left\{-5s^2-30s+15 = 3(s^2+2s+5) + Bs^2 + Cs\right\}$

$\therefore$ $-5 = 3 + B \Rightarrow B = -8$

$-30 = 6 + C \Rightarrow C = -36$

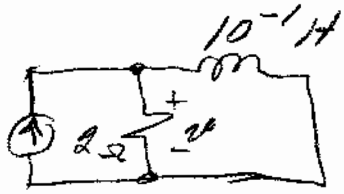
$15 = 15$

$$F(s) = \frac{3}{s} - \frac{8s+36}{(s+1)^2+4} = \frac{3}{s} - \frac{8(s+1) + 28\left(\frac{2}{2}\right)}{(s+1)^2+4}$$

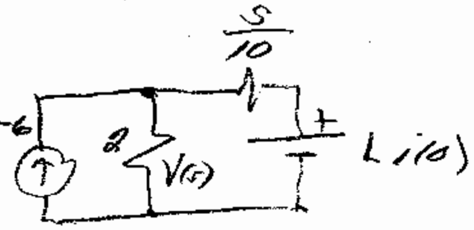
$$\boxed{f(t) = 3u(t) - \left(8e^{-t}\cos 2t - 14e^{-t}\sin 2t\right)u(t)}$$

EE212 Homework 10

15.110 $10^{-6}\times 25u(t)$



$\Rightarrow \frac{25\times10^{-6}}{s}$



with no source before $t=0$

$i(0)=0$

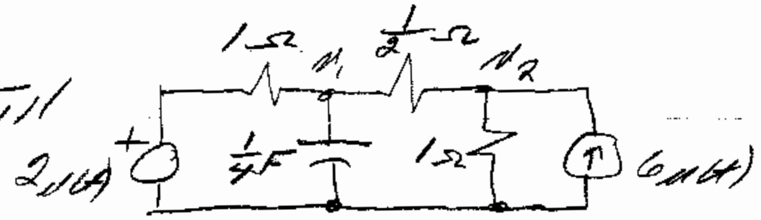
$$V(s) = \frac{\cancel{25}^{\,5}\times10^{-6}}{\cancel{s}}\times\frac{\frac{\cancel{s}}{\cancel{5}}}{2+\frac{s}{10}} = \frac{5\times10^{-6}}{2+\frac{s}{10}} = \frac{5\times10^{-5}}{s+20}$$

$$\therefore\ v(t) = 5\times10^{-5}e^{-20t}u(t)$$

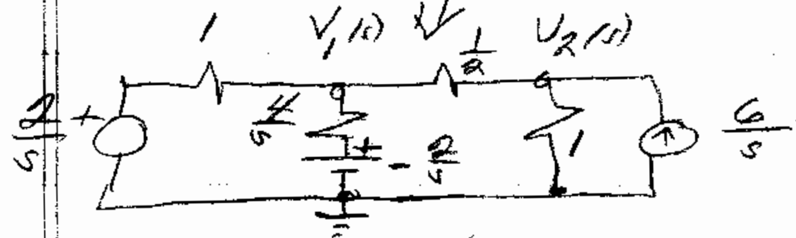
$$P_{resistor}(t) = \frac{v^2}{2} = 12.5\times10^{-10}e^{-40t} = \boxed{1.25\times10^{-9}e^{-40t}\,W}$$

EE 212 Homework 11

15.11



$v_1(0^-) = -2$



$$\frac{V_1 - \frac{2}{s}}{1} + \frac{V_1 + \frac{2}{s}}{4/s} + \frac{V_1 - V_2}{1/2} = 0 \quad \left\{ \begin{array}{l} V_1\left(3 + \frac{s}{4}\right) - 2V_2 = -\frac{1}{2} + \frac{2}{s} \\ -2V_1 + 3V_2 = \frac{6}{s} \end{array} \right.$$

$$\frac{V_2 - V_1}{1/2} + \frac{V_2}{1} = \frac{6}{s}$$

$$V_1(12 + s) - 8V_2 = -2 + \frac{8}{s}$$

or $$V_1(-2s) + V_2(3s) = 6$$

$$V_1 = \frac{\begin{vmatrix} -2+\frac{8}{s} & -8 \\ 6 & 3s \end{vmatrix}}{\begin{vmatrix} 12+s & -8 \\ -2s & 3s \end{vmatrix}} = \frac{\overbrace{\cancel{-6s+24+48}}^{72}}{\underbrace{36s + 3s^2 - 16s}_{3s^2+20s}} = \frac{72 - 6s}{s(20 + 3s)}$$

$$V_1 = \frac{24 - 2s}{s\left(s + \frac{20}{3}\right)} = \frac{\frac{18}{5}}{s} - \frac{\frac{28}{5}}{s + \frac{20}{3}}$$

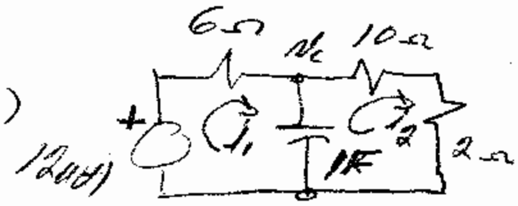
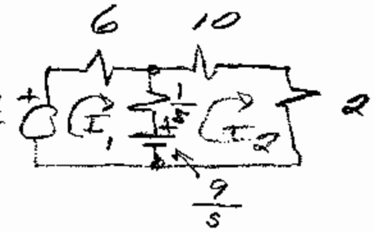
$$V_2 = \frac{\begin{vmatrix} 12+s & -2+\frac{8}{s} \\ -2s & 6 \end{vmatrix}}{s(20+3s)} = \frac{72 + 6s - 4s + 16}{s(20+3s)} = \frac{88 + 2s}{3s\left(s + \frac{20}{3}\right)} = \frac{\frac{88}{3} + \frac{2}{3}s}{s\left(s + \frac{20}{3}\right)}$$

$$V_2 = \frac{\frac{22}{5}}{s} - \frac{\frac{56}{15}}{s + \frac{20}{3}}$$

$$\therefore v_1(t) = \left\{\frac{18}{5} - \frac{28}{5} e^{-\frac{20t}{3}}\right\} u(t) = \left\{3.6 - 5.6 e^{-6.67t}\right\} u(t)$$

$$v_2(t) = \left\{\frac{22}{5} - \frac{56}{15} e^{-\frac{20t}{3}}\right\} u(t) = \left\{4.4 - 3.73 e^{-6.67t}\right\} u(t)$$

EE 212 Homework 12

15.13 a)  $\Rightarrow$ 

$v_c(0) = 9V$

$$\frac{12}{s} = 6I_1 + \frac{1}{s}(I_1 - I_2) + \frac{9}{s} \qquad I_1\left(6+\frac{1}{s}\right) - I_2\frac{1}{s} = \frac{3}{s}$$

$$\frac{9}{s} = (I_2 - I_1)\frac{1}{s} + 12 I_2 \qquad -I_1\frac{1}{s} + I_2\left(12+\frac{1}{s}\right) = \frac{9}{s}$$

multiplying by s gives:
$$\left[\begin{aligned} I_1(6s+1) - I_2 &= 3 \\ -I_1 + I_2(12s+1) &= 9 \end{aligned}\right]$$

$$I_1 = \frac{\begin{vmatrix} 3 & -1 \\ 9 & 12s+1 \end{vmatrix}}{\begin{vmatrix} 6s+1 & -1 \\ -1 & 12s+1 \end{vmatrix}} = \frac{36s+3+9}{72s^2+6s+12s+1-1} = \frac{36s+12}{s(72s+18)} = \frac{6s+2}{s(12s+3)}$$

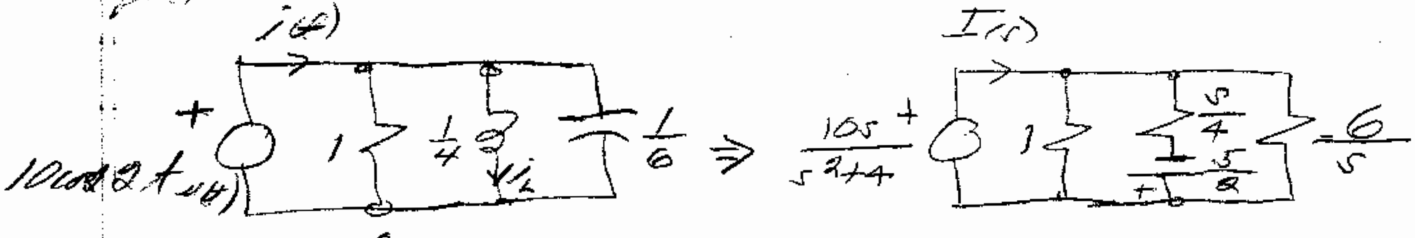
$$I_1 = \frac{6s+2}{12s(s+\frac{1}{4})} = \frac{\frac{2}{3}}{s} + \frac{-\frac{1}{6}}{s+\frac{1}{4}} \quad \therefore \boxed{i_1(t) = \left\{\frac{2}{3} - \frac{1}{6}e^{-\frac{t}{4}}\right\}u(t)}$$

$$I_2 = \frac{\begin{vmatrix} 6s+1 & 3 \\ -1 & 9 \end{vmatrix}}{s(72s+18)} = \frac{54s+\overbrace{9+3}^{12}}{s(72s+18)} = \frac{9s+2}{12s(s+\frac{1}{4})} = \frac{\frac{2}{3}}{s} + \frac{\frac{1}{12}}{s+\frac{1}{4}}$$

$$\text{so } i_2(t) = \left\{\frac{2}{3} + \frac{1}{12}e^{-\frac{t}{4}}\right\}u(t)$$

Homework 13

Special



$i_L(0)=10$

$$I(s) = \frac{10s}{s^2+4} + \frac{\frac{10s}{s^2+4}+\frac{5}{2}}{\frac{5}{4}} + \frac{\frac{10s}{s^2+4}}{\frac{6}{s}}$$

$$I(s)=\frac{10s}{s^2+4}+\frac{40}{s^2+4}+\frac{10}{s}+\frac{10s^2}{6(s^2+4)}$$

$-\frac{20}{3}+\frac{120}{\ }$

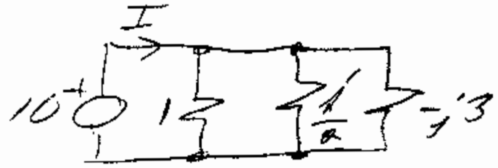
$$I(s)=\frac{10s}{s^2+4}+\frac{40}{s^2+4}+\frac{10}{s}+\frac{5}{3}\left[1-\frac{4}{s^2+4}\right]$$

$$I(s)=\frac{10s}{s^2+4}+\frac{\cancel{100}^{\,50}}{\cancel{2}\times 3}\cdot\frac{2}{s^2+4}+\frac{10}{s}+\frac{5}{3}$$

$$\boxed{i(t)=\left\{10\cos 2t+\frac{50}{3}\sin 2t+10\right\}u(t)+\frac{5}{3}\delta(t)}$$

or $$i(t)=\left\{\sqrt{10^2+\left(\frac{50}{3}\right)^2}\cos\left(2t-\tan^{-1}\frac{5}{3}\right)+10\right\}u(t)+\frac{5}{3}\delta(t)$$

check of sinusoidal steady state

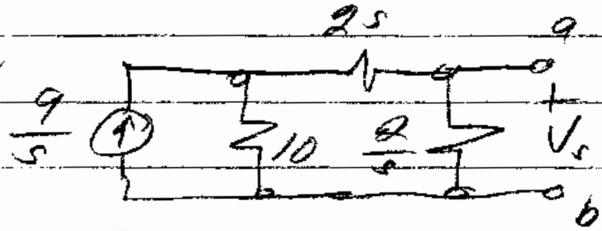


$$\hat{I}=10-j20+j\frac{10}{3}=10-j\left(\frac{50}{3}\right)=\sqrt{10^2+\left(\frac{50}{3}\right)^2}\,e^{-j\tan^{-1}\left(\frac{5}{3}\right)}$$

$$i(t)=\mathrm{Re}\left\{\hat{I}e^{j2t}\right\}=\sqrt{10^2+\left(\frac{50}{3}\right)^2}\cos\left(2t-\tan^{-1}\frac{10}{6}\right)$$

EE 212 Homework 14

15-28



$$V_{Th}(s) = \frac{9}{s} \cdot \frac{10}{10+2s+\frac{2}{s}} \cdot \frac{2}{s} = \frac{9}{s} \cdot \frac{20}{2s^2+10s+2}$$

$$\boxed{V_{Th}(s) = \frac{90}{s(s^2+5s+1)}}$$

$$Z_{Th} = \frac{\frac{2}{s}(2s+10)}{\frac{2}{s}+2s+10} = \frac{4s+20}{2s^2+10+2} = \boxed{\frac{2s+10}{s^2+5s+1}}$$

EE 212 Homework 15

15.42 $f_1(t) = e^{-5t}u(t)$; $f_2(t) = (1-e^{-2t})u(t)$

$$y(t) = \int_0^t e^{-5(t-\tau)} u(t-\tau)(1-e^{-2\tau})u(\tau)\,d\tau$$

$$= e^{-5t}\int_0^t e^{5\tau}(1-e^{-2\tau})\,d\tau = e^{-5t}\left\{\frac{1}{5}e^{5\tau} - \frac{1}{3}e^{3\tau}\right\}_0^t u(t)$$

$$y(t) = e^{-5t}\left\{\frac{1}{5}\left[e^{5t} - \frac{1}{5}\right] - \frac{1}{3}\left[e^{3t} - 1\right]\right\}u(t)$$

$$y(t) = \left\{\frac{1}{5}\left[1 - e^{-5t}\right] - \frac{1}{3}\left[e^{-2t} - e^{-5t}\right]\right\}u(t)$$

$$\boxed{y(t) = \left\{\frac{1}{5} + \frac{2}{15}e^{-5t} - \frac{1}{3}e^{-2t}\right\}u(t)}$$

$F_1(s) = \frac{1}{s+5}$; $F_2(s) = \frac{1}{s} - \frac{1}{s+2}$

$$\therefore Y(s) = F_1(s)F_2(s) = \frac{1}{s}\cdot\frac{1}{s+5} - \frac{1}{(s+2)(s+5)}$$

$$Y(s) = \frac{\frac{1}{5}}{s} + \frac{-\frac{1}{5}}{s+5} - \frac{\frac{1}{3}}{s+2} - \frac{-\frac{1}{3}}{s+5} = \frac{\frac{1}{5}}{s} - \frac{\frac{1}{3}}{s+2} + \frac{\frac{2}{15}}{s+5}$$

so $\boxed{y(t) = \left\{\frac{1}{5} - \frac{1}{3}e^{-2t} + \frac{2}{15}e^{-5t}\right\}u(t)}$

EE 212 Homework 16

15.44 $h(t) = 2e^{-3t}u(t)$; $x(t) = u(t) - \delta(t)$

a) $$y(t) = \int_0^t 2e^{-3(t-z)} u(t-z)\left[u(z) - \delta(z)\right] dz$$

$$= 2e^{-3t}\left(\frac{1}{3}\right)e^{3z}\Big|_0^t - 2e^{-3t}\int_0^t e^{3z}\,\delta(z)\,dz$$

$$y(t) = \frac{2}{3}e^{-3t}\left[e^{3t} - 1\right]u(t) - 2e^{-3t}u(t)$$

$$y(t) = \boxed{\left\{\frac{2}{3} - \frac{8}{3}e^{-3t}\right\}u(t)} \longleftarrow$$

b) $H(s) = \dfrac{2}{s+3}$; $X(s) = \dfrac{1}{s} - 1$

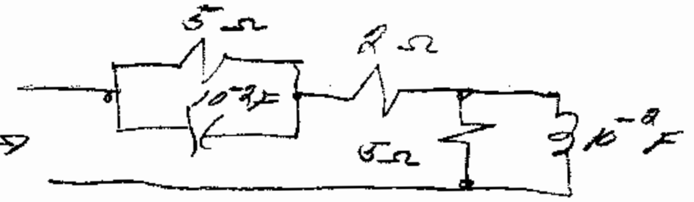
$$Y(s) = H(s)\,X(s) = \frac{2}{s(s+3)} - \frac{2}{s+3} = \frac{}{s} + \frac{}{s+3} - \frac{2}{s+3}$$

$$Y(s) = \frac{\frac{2}{3}}{s} + \frac{-\frac{2}{3} - 2}{s+3} = \frac{\frac{2}{3}}{s} - \frac{\frac{8}{3}}{s+3}$$

so $$y(t) = \boxed{\left\{\frac{2}{3} - \frac{8}{3}e^{-3t}\right\}u(t)} \longleftarrow$$

Homework 17

16.8



$$Z_{in} = 2 + \frac{\frac{5}{j\omega 10^{-2}}}{5 + \frac{1}{j\omega 10^{-2}}} + \frac{5j\omega 10^{-2}}{5 + j\omega 10^{-2}} = 2 + \frac{5}{1 + j\omega 5\times10^{-2}} + \frac{j\omega 5\times10^{-2}}{5 + j\omega 10^{-2}}$$

$$Z_{in} = 2 + \frac{5(1 - j\omega 5\times10^{-2})}{1 + 25\omega^2\times10^{-4}} + \frac{j\omega 5\times10^{-2}(5 - j\omega 10^{-2})}{25 + \omega^2\times10^{-4}}$$

@ resonance $$\frac{-25\omega\times10^{-2}}{1 + 25\omega^2\times10^{-4}} + \frac{\omega 25\times10^{-2}}{25 + \omega^2\times10^{-4}} = 0$$

or $$25 + \omega^2\times10^{-4} = 1 + 25\omega^2\times10^{-4} \Rightarrow 24 = 24\omega^2\times10^{-4}$$

$$\omega_0 = \sqrt{\frac{1}{10^{-4}}} = 10^2 \quad \text{or} \quad f_0 = 15.9\ Hz$$

$$Z_{in}(\omega_0) = 2 + \frac{5}{1+25} + \frac{5\times10^4\times10^{-4}}{25+1} = \frac{52+10}{26} = \frac{62}{26} = \boxed{2.38\ \Omega}$$

16.25 $BW = 10^6\ Hz$, $f_1 = 5.5\ kHz$

a) $\omega_1 = 2\pi\times5.5\times10^3$

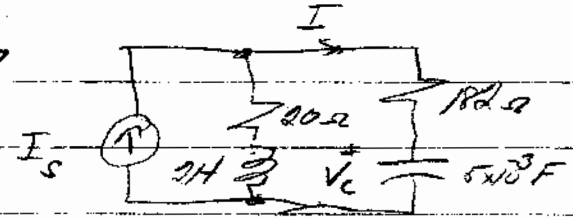
$$f_2 = f_1 + BW = 5.5\times10^3 + 10^6 = \boxed{1.0055\times10^6\ Hz}$$

b) $$f_0 = \sqrt{f_2 f_1} = \sqrt{5.5\times10^3\times1.0055\times10^6} = \boxed{74.37\times10^3\ Hz}$$

c) $$Q_0 = \frac{f_0}{BW} = \frac{74.37\times10^3}{10^6} = \boxed{0.074}$$

EE 212 Homework 18

16.57



$$H(j\omega) = \frac{\hat{V}_c}{\hat{I}_s}$$

$$H(s) = \frac{V_c(s)}{I_s(s)}$$

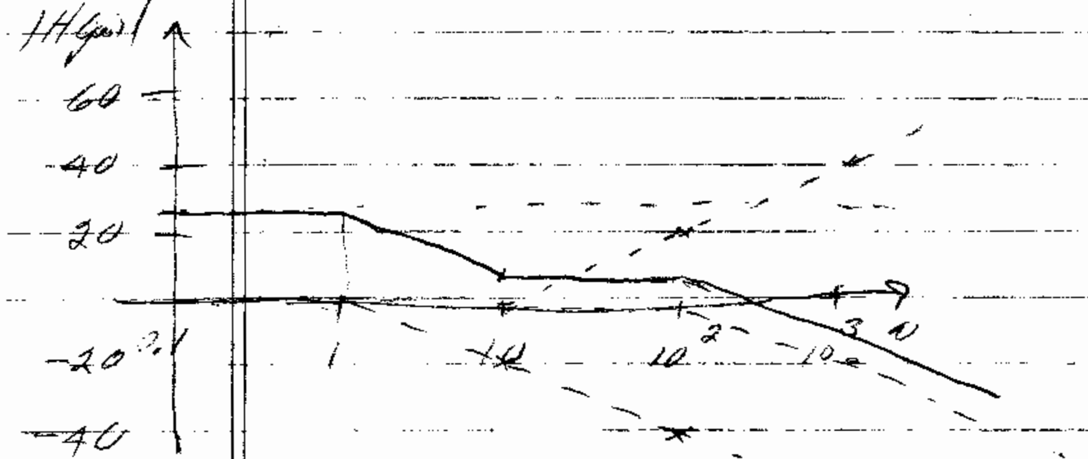
$$I(s) = I_s \frac{20+2s}{202+2s+\frac{1}{s\times5\times10^{-3}}}$$

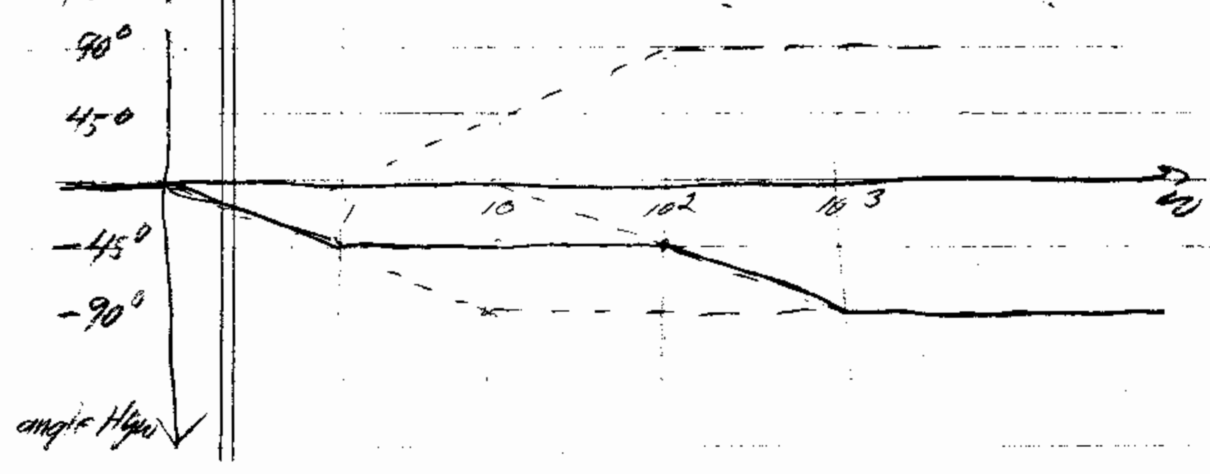
$$V_c(s) = I(s)\frac{1}{s\times5\times10^{-3}} = \frac{(20+2s)\cancel{\frac{I_s}{s\times5\times10^{-3}}}}{\frac{1.01s+10^{-2}s^2+1}{\cancel{s\times5\times10^{-3}}}} = \frac{(20+2s)I_s}{10^{-2}s^2+1.01s+1}$$

$$\therefore H(s) = \frac{10^2(20+2s)}{s^2+101s+1} = \frac{2\times10^2(s+10)}{(s+1)(s+100)}$$

$$H(j\omega) = 20\frac{\left(1+j\frac{\omega}{10}\right)}{\left(1+j\frac{\omega}{1}\right)\left(1+j\frac{\omega}{100}\right)}$$

$\boxed{20\log_{10}20 = 26\,dB}$

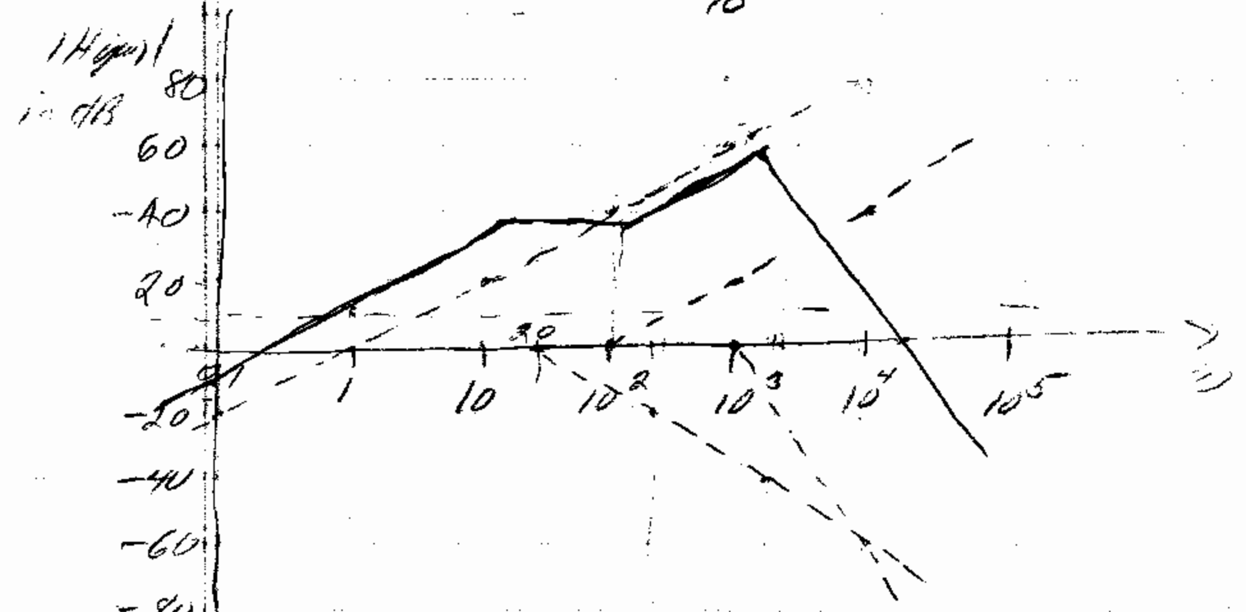




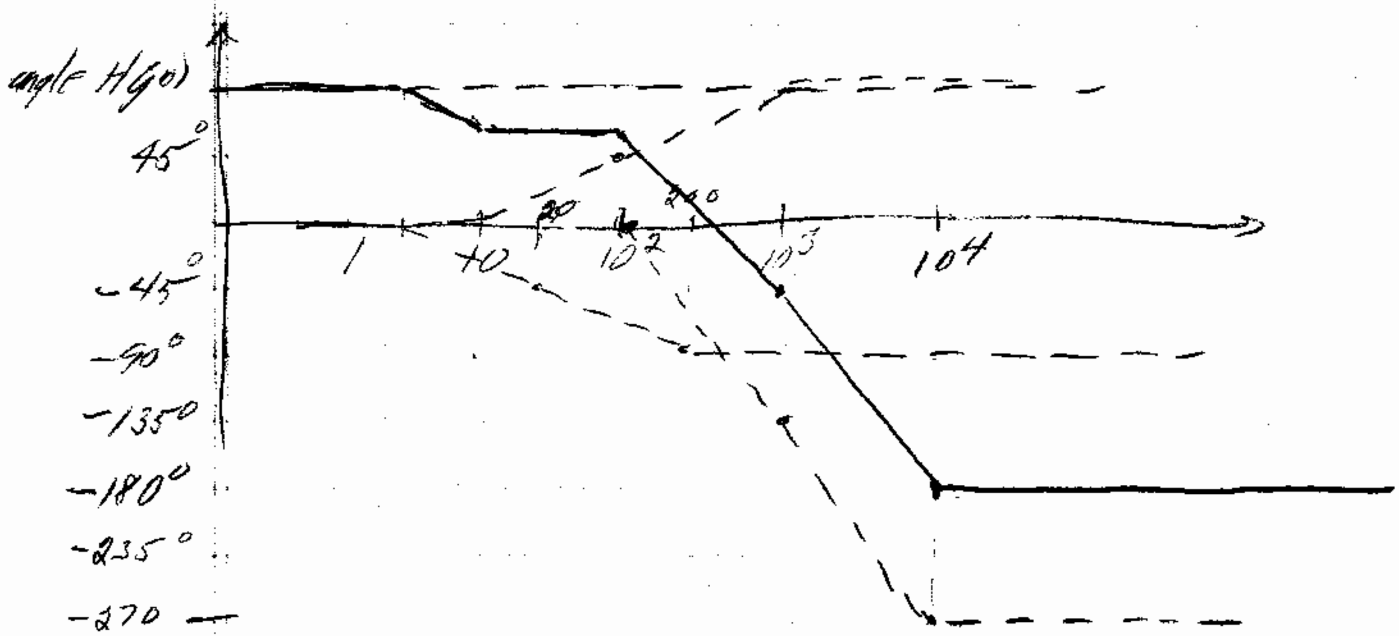
EE 212 Homework 19

16.58a) $H(s) = \dfrac{5\times10^8 s(s+100)}{(s+20)(s+10^3)^3} = \dfrac{5\times10^8 \times 10^2 s(1+\frac{s}{100})}{20\times10^9(1+\frac{s}{20})(1+\frac{s}{10^3})^3}$

$H(j\omega) = \dfrac{5}{2}\,\dfrac{j\omega(1+\frac{j\omega}{100})}{(1+\frac{j\omega}{20})(1+\frac{j\omega}{10^3})^3}$; $20\log_{10}(\frac{5}{2}) = 7.96$

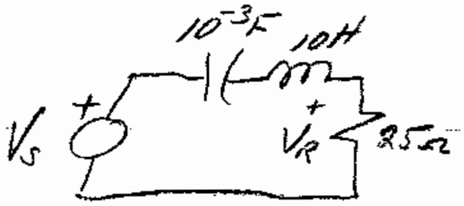


16.59a)



EE 212 Homework 20

16.61



$$\frac{V_R(s)}{V_s(s)} = \frac{25}{25 + 10s + \frac{1}{10^{-3}s}} = H(s)$$

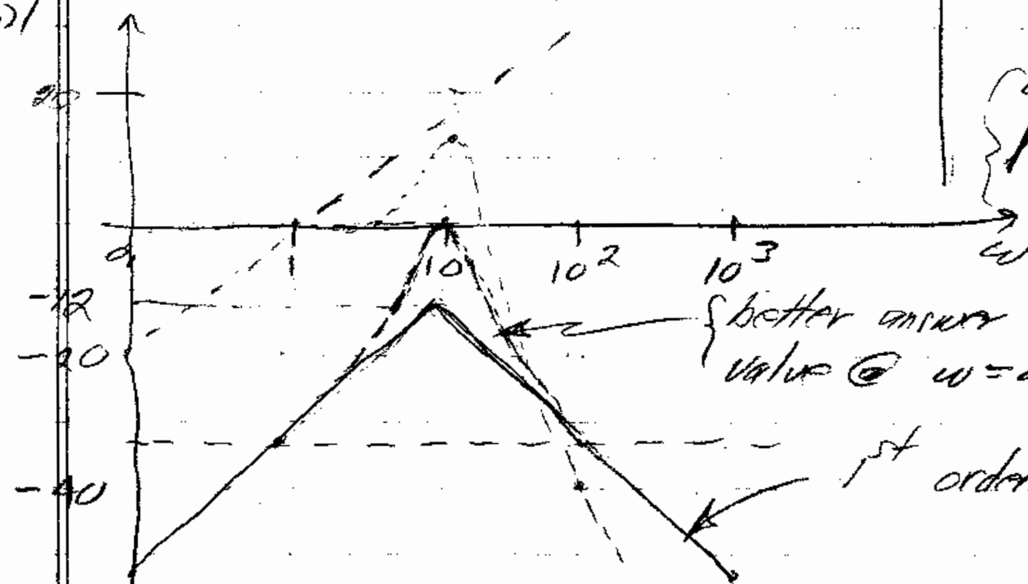
a) $$H(s) = \frac{25s}{10s^2 + 25s + 10^3} = \frac{25}{10^3}\;\frac{s}{1 + 25\times10^{-3}s + \frac{s^2}{100}}$$

$\boxed{\omega_0 = 10}$; $\frac{2\zeta}{\omega_0} = 25\times10^{-3}$; so $\zeta = \frac{25\times10^{-3}\times10}{2}$

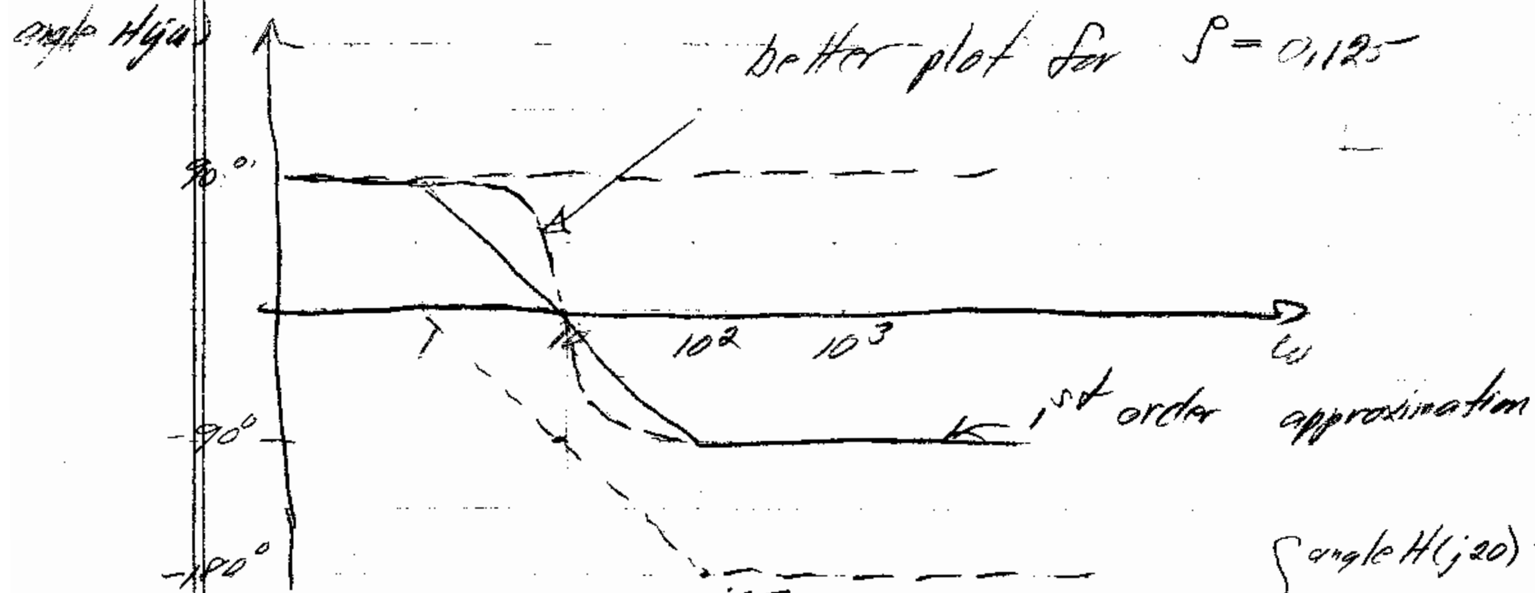
$\boxed{\zeta = 0.125}$

b) $$H(j\omega) = \frac{0.025\,j\omega}{1 + 2\left(\frac{1}{8}\right)\frac{1}{10}j\omega - \frac{\omega^2}{10^2}}$$

$\left[20\log_{10} 0.025\right] = -32$



at $\omega = \omega_0$ |denominator of $H(j\omega)$| $= 20\log_{10}\frac{1}{4} = -12$

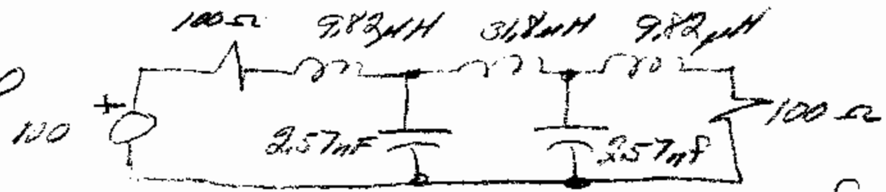


c) @ $\omega = 20$ $|H(j20)| = \left|\frac{j0.5}{1-4+j0.5}\right| \Rightarrow |H(j20)|_{\text{in dB}} = -15.68$; $\left\{\text{angle } H(j20) = \underline{-80.54^\circ}\right\}$

EE 212 Homework 21

16.62

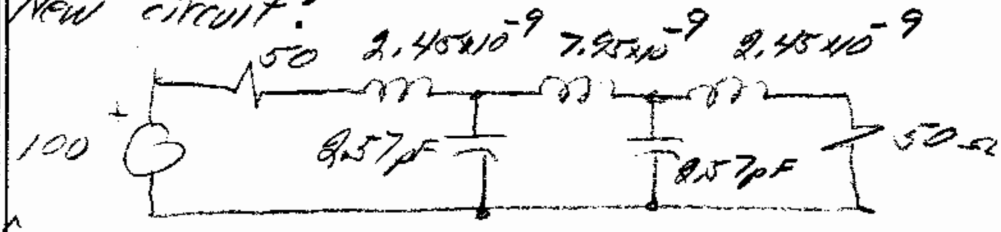
16.50

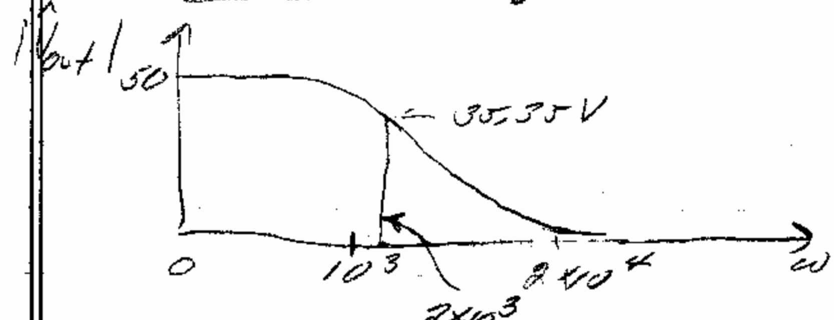


Magnitude scaling factor $= \frac{1}{2}$ $\left\{ R' = \frac{R}{2},\ L' = \frac{L}{2},\ C' = 2C \right\}$

frequency scaling factor $= 2\times10^3$ $\left\{ R' = R,\ L' = L/2\times10^3,\ C' = C/2\times10^3 \right\}$

New circuit:





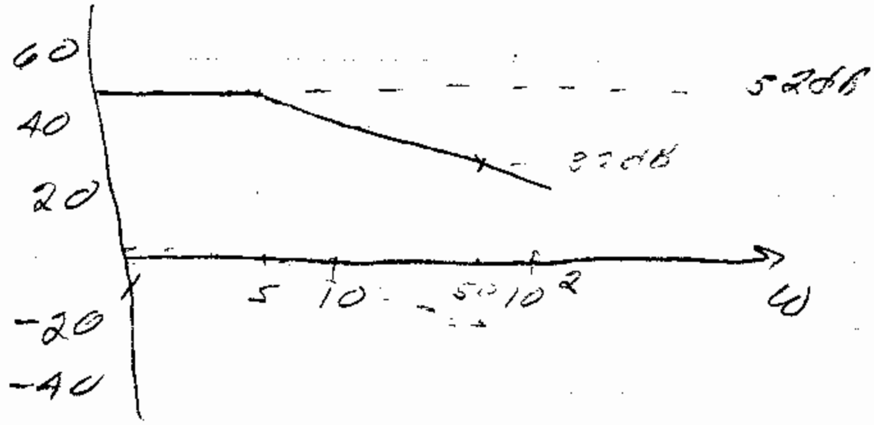
OK for original cutoff frequency = 1 (see next page for $f_c = 10^3$)

16.62 1^{st} stage $H_1(s) = -10$; 2^{nd} stage $H_2(s) = -10$

3^{rd} stage $H_3(s) = -\dfrac{\dfrac{2\times10^5\left(\frac{1}{5\times10^{-6}}\right)}{2\times10^5 + \frac{1}{5\times10^{-6}}}}{5\times10^4} = -\dfrac{2\times10^5}{5\times10^4}\cdot\dfrac{1}{1+5\times2\times10^{-1}}$

$\therefore$ total $H(s) = H_1(s)H_2(s)H_3(s) = -\frac{2}{5}\times10^{+3}\dfrac{1}{1+s\times0.2} = \boxed{-400\dfrac{1}{1+\frac{s}{5}}}$

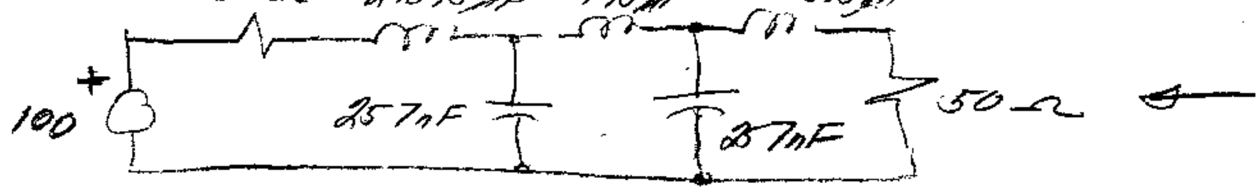
$20\log_{10}400 = 52dB$



No. 50 for original $f_{cutoff} = 10^6$ Hz

Magnitude scaling factor $= \frac{1}{2}$

frequency scaling factor $= \frac{20\times10^3}{10^6} = 2\times10^{-2}$



plot the same as previous page!