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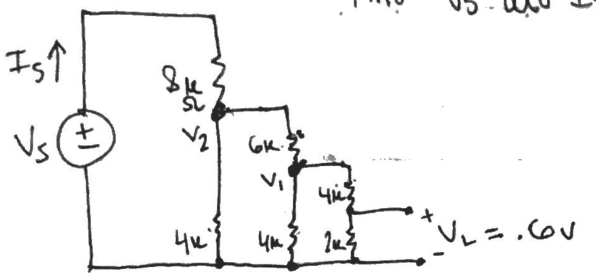
ECEN 325

HW #1

1) a) Find V_s and I_s



$$.6V = \frac{2k}{4k+2k} V_1 \qquad V_1 = 1.8V$$

$$\cancel{1.8V = \frac{4k}{4k+6k} V_2} \qquad \cancel{V_2 = 4.5V}$$

$$V_2 = 6.3V$$

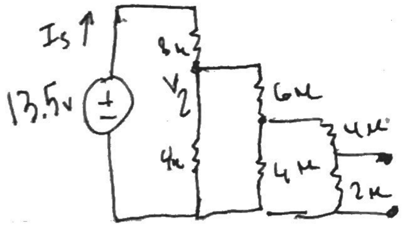
$$1.8V = \frac{4k \,||\, (4k+2k)}{(4k \,||\, 4k+2k) + 6k} V_2$$

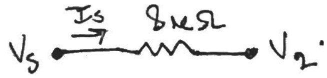
$$\cancel{4.5V = \frac{4k}{8k+4k} V_s}$$

$$6.3V = \frac{(4k \,||\, (6k + (4k \,||\, 4k+2k))}{8k + (4k \,||\, (6k + (4k \,||\, 4k + 2k)}V_s$$

$\cancel{V_s = 13.5V}$

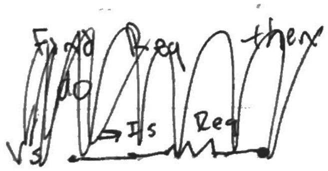
$$\boxed{V_s = 24.9V}$$





$V_s = \cancel{13.5V}$ 24.9V

$V_2 = \cancel{4.5V}$ 6.3V

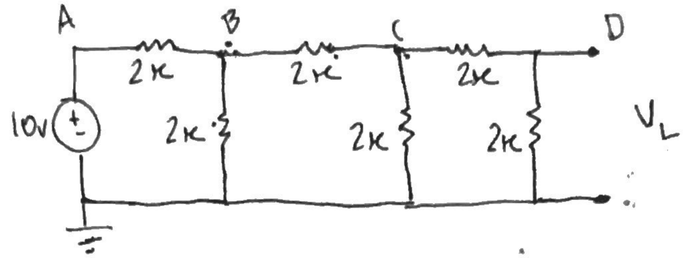


$$I_s = \cancel{\frac{13.5V - 4.5V}{8000\Omega}} \quad \frac{24.9V - 6.3V}{8000\,\Omega}$$

$\cancel{I_s = 1.125\ mA}$

$$\boxed{I_s = 2.325\ mA}$$

1)b)



$\cancel{V_B = \frac{2k}{2k+2k} 10v}$

$\cancel{V_B = 5v}$

$\cancel{V_B = 2.22v}$

$V_B = 3.846v$

$V_B = 10 \frac{(2k \,||\, (2k + (2k \,||\, 4k)))}{2k + (2k \,||\, (2k + (2k \,||\, 4k)))}$

$\cancel{V_C = \frac{2k}{2k+2k} 5v}$

$\cancel{V_C = 2.5v}$

$V_C = 1.5384$

$V_C = 3.846v \frac{(2k \,||\, 4k)}{2k + (2k \,||\, 4k)}$

$\cancel{V_L = V_D = \frac{2k}{2k+2k} 2.5v}$

$\cancel{V_L = 1.25v}$ $\cancel{768mV}$

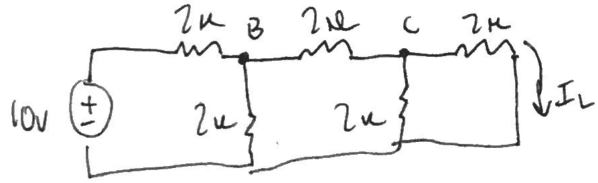
$\boxed{V_L = 769mV}$

$V_L = \frac{2k}{4k} \cdot 1.5384$

$\cancel{R_L = 300\Omega}$
$\cancel{V_L = 1.25v}$

$\cancel{I_L = \frac{1.25v}{300\Omega} = 4.16mA}$

$\cancel{I_L = 4.16mA}$ $\cancel{.8274mA}$



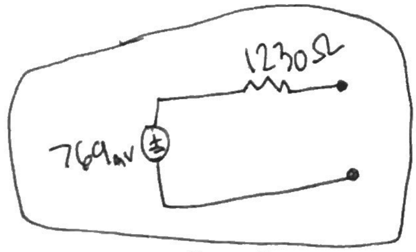
$V_B = 10 \frac{2k \,||\, (2k + 1k)}{2k + (2k \,||\, (2k + 1k))}$

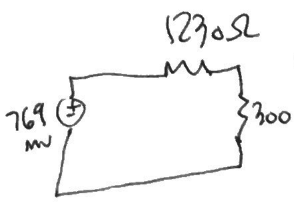
$V_B = 3.75v$

$V_C = 3.75 \frac{1k}{1k + 2k}$

$V_C = 1.25v$

$\frac{1.25}{2k} = 6.25E-4A$

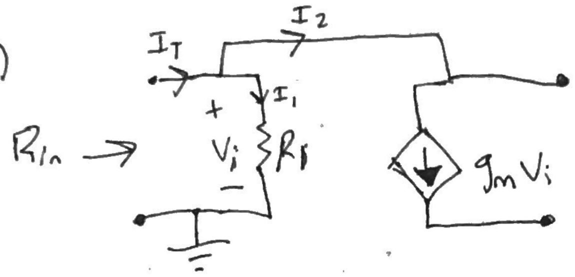




$\cancel{V_L = .769 \frac{300}{1230} = .18756}$

$I_L = \frac{.769}{1230 + 300} = \boxed{5.026E-4 \text{ A}}$

1)c)



$$I_1 = \frac{V_i}{R_{in}}$$

$$I_T = I_1 + I_2$$

$$I_T = \frac{V_i}{R_{in}} + g_m V_i$$

$$I_T = V_i\left(\frac{1}{R_{in}} + g_m\right)$$

$$\frac{V_i}{I} = \frac{V_i}{V_i\left(\frac{1}{R_1} + g_m\right)}$$

$$\boxed{R_{in} = \frac{R_1}{1 + R_1 g_m}}$$

2) $\text{gain} = \frac{|V_{out}|}{|V_{in}|}$ $\quad$ db $= 20\log_{10}(\omega/\omega_c)$

$\phi = -\tan^{-1}(\omega/\omega_c)$

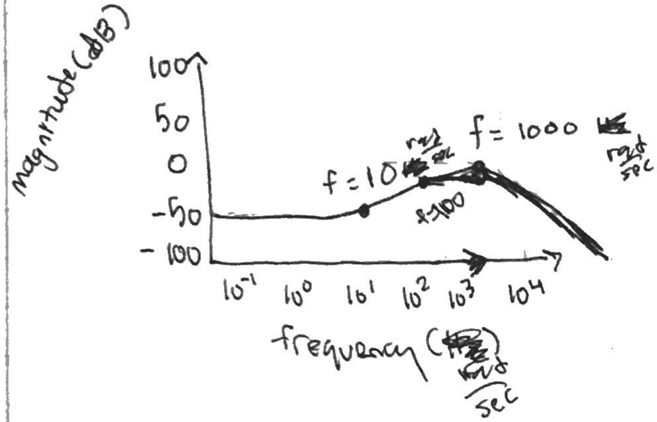
Standard form of the transfer function, $H(\omega)$, is where the terms ω are written such that the ~~real~~ ~~part~~ imaginary part is written as the reciprocal of an angular frequency (ω_z or ω_p)

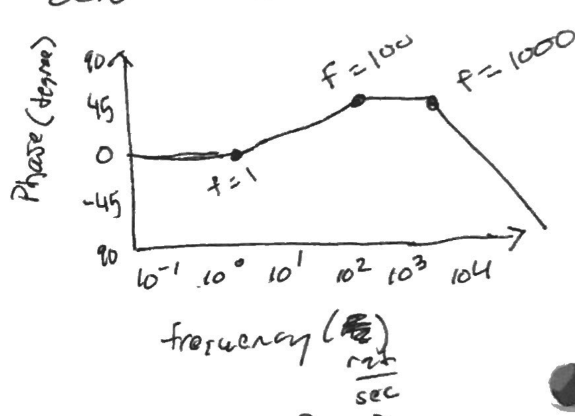
Transfer function is comprised of $H(\omega) = M(\omega)e^{j\phi(\omega)}$ which is magnitude, $M(\omega)$, and phase angle $\phi(\omega)$

$$H_1(s) = \frac{30(10+s)}{(200+2s)(1000+2s)} = \frac{10\cdot 30}{100\cdot 1000}\,\frac{\left(\frac{s}{10}+1\right)}{\left(\frac{s}{100}+1\right)\left(\frac{s}{1000}+1\right)}$$

$$= .003\,\frac{\left(\frac{s}{10}+1\right)}{\left(\frac{s}{100}+1\right)\left(\frac{s}{1000}+1\right)}$$

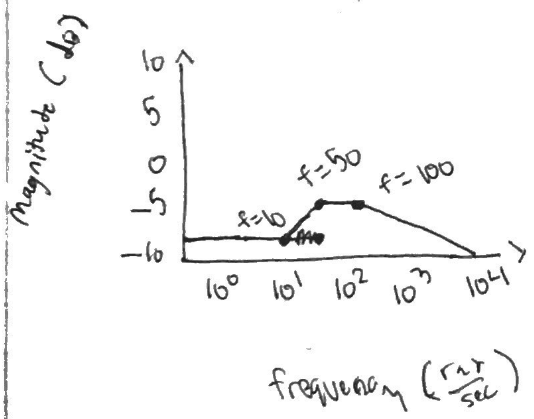
Constant = .003 = −50 dB
Poles = −100, −1000
Zero = −10

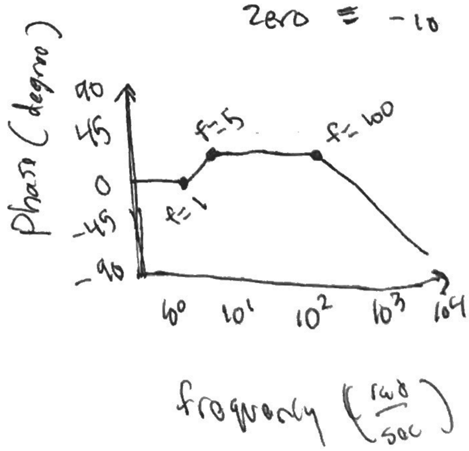




$$H_2(s) = 400\,\frac{(6s+60)}{(2s+4)(2s+100)(4s+400)} = \frac{400\cdot 10}{2\cdot 50\cdot 100}\,\frac{\left(\frac{s}{10}+1\right)}{\left(\frac{s}{2}+1\right)\left(\frac{s}{50}+1\right)\left(\frac{s}{100}+1\right)}$$

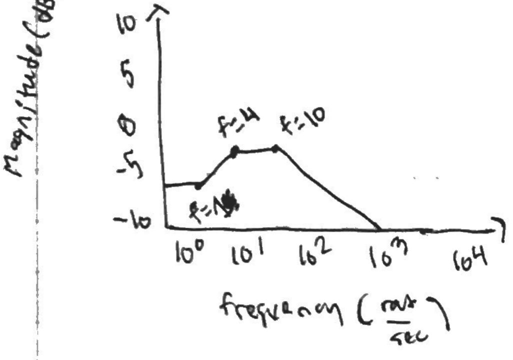
Constant = .4 = −8 db
Poles = −2, −50, −100
Zero = −10

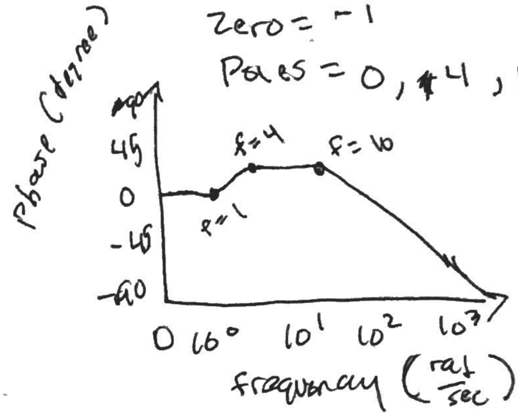




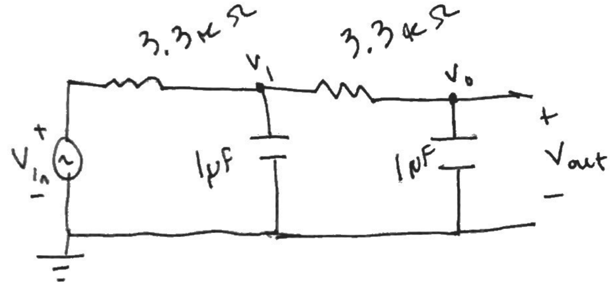
$$H_3(s) = 8\,\frac{10+10s}{s(s^2+4s+16)} = 8\cdot\frac{1}{16}\,\frac{\left(\frac{s}{1}+1\right)}{s\left(\frac{s^2}{16}+\frac{s}{4}+1\right)} = .5\,\frac{\frac{s}{1}+1}{s\left(\frac{s^2}{16}+\frac{s}{4}+1\right)}$$

Constant = .5 = -6 dB
Zero = -1
Poles = 0, ~~#~~4, 1, .125





3) a)



$$\frac{V_1 - V_{in}}{R_1} + \frac{V_1}{\frac{1}{sC_1}} + \frac{V_1}{R_2+\frac{1}{sC_2}} = 0 \qquad V_1\left[\frac{1}{R_1} + sC_1 + \frac{sC_2}{R_2sC_2+1}\right] = \frac{V_{in}}{R_1}$$

$$V_1[1 + sC_2R_2 + R_1R_2s^2C_1C_2 + sC_1R_1 + sC_2R_1] = V_{in}[1+sC_2R_2]$$
$$V_1[s^2C_1C_2R_1R_2 + s[C_2R_2 + C_1R_1 + C_2R_1] + 1] = V_{in}[1+sC_2R_2]$$

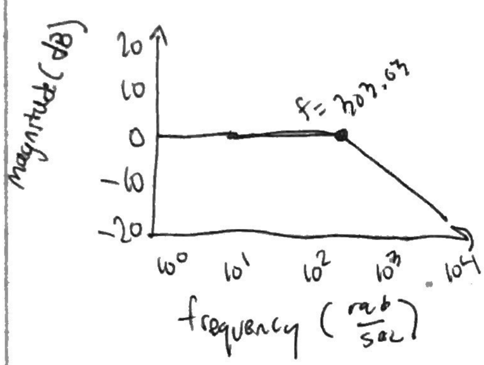
$$V_{out} = \frac{V_1}{R_2sC_2+1} = \frac{V_{in}}{s^2C_1C_2R_1R_2 + s(C_2R_2 + C_1R_1 + C_2R_1) + 1}$$

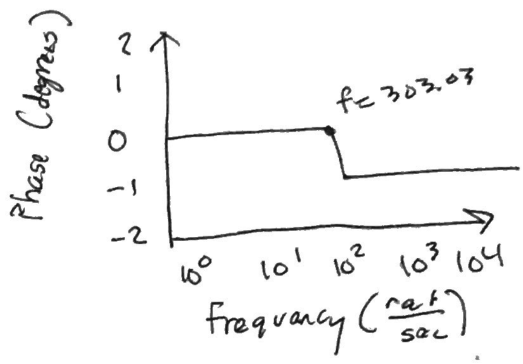
~~H(s) = 91827.365 / (s + 4.95E-3)^2 +~~ ~~s^2 / 91827.365 + (3E-6)(3)~~

$$\boxed{H(s) = \frac{91827.365}{(s+4.95E{-3})^2 + (.999)^2}}$$

pole = 303.03 rad/sec

constant = 0 dB





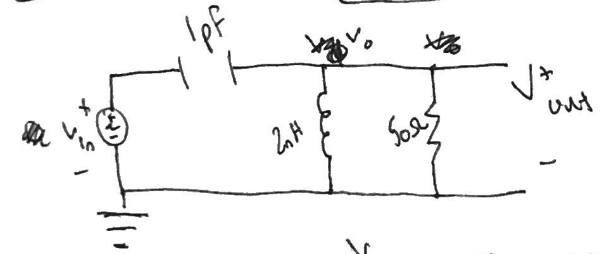
$$\text{gain} = \frac{|V_o|}{|V_{in}|} = 1 \quad \frac{1/C^2R^2}{s^2 + s\frac{C_1(3R)}{C^2R^2} + \frac{1}{C^2R^2}}$$

gain = 1 @ $w = 0$

gain = 0 @ $w = \infty$

low pass

b)



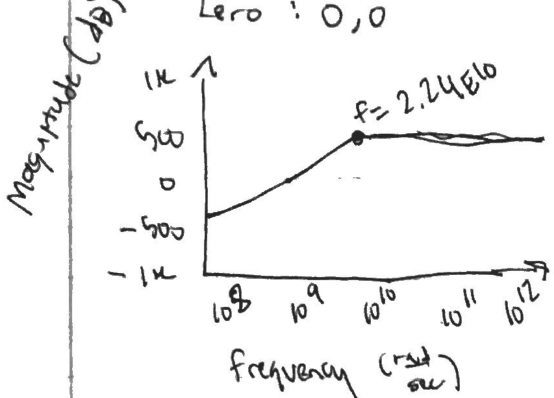
$$\frac{V_1}{SL} + \frac{V_0}{R} + \frac{V_0 - V_{in}}{SC} = 0$$

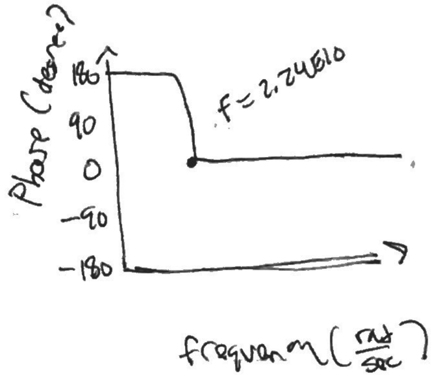
$$V_0\left[\frac{1}{SL} + \frac{1}{R} + SC\right] = V_{in} \cdot SC$$

$$V_0\left[R + SL + S^2LCR\right] = V_{in}\left[S^2RLC\right]$$

$$H(s) = \frac{s^2}{s^2 + s(2E10) + 5E20}$$

Pole: 2.24E10
Constant: -413 dB
Zero: 0,0



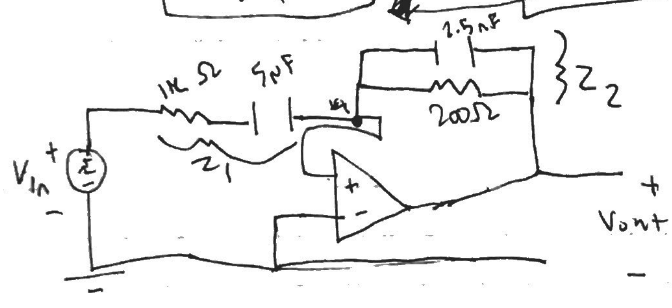


$$\frac{s^2}{s^2 + (2E10)s + 5E20}$$

highpass

@ s=0 gain = 0
@ s=∞ gain = 1

c)

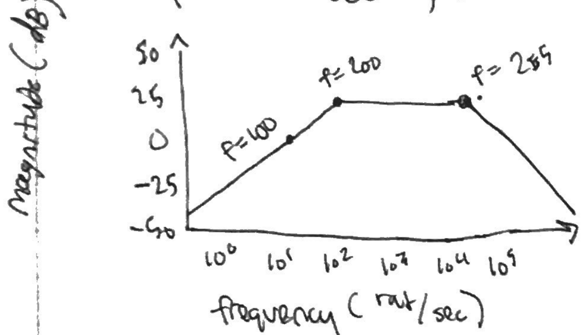


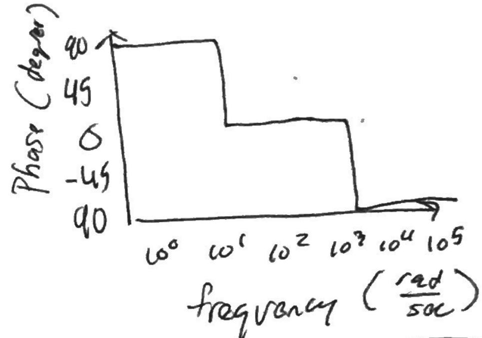
$$\frac{0 - v_{in}}{Z_1} + \frac{0 - V_o}{Z_2} = 0 \qquad \frac{V_o}{V_{in}} = \frac{-Z_2}{Z_1} \qquad Z_1 = R_1 + \frac{1}{sC_1}$$

$$Z_2 = \frac{200}{5E\text{-}6s + 1}$$

$$\frac{V_o}{V_{in}} = -\frac{\frac{200}{(5E\text{-}6)s+1}}{R_1 + 1/sC_1} = \boxed{\frac{-.01s}{\left(1 + \frac{s}{200}\right)\left(1 + \frac{s}{2E5}\right)}}$$

Constant = -40 dB
Zero = - 100
Pole = -200 , -2E5





$$\frac{-.01s}{\left(1+\frac{s}{200}\right)\left(1+\frac{s}{2000}\right)}$$

gain @ s=0 =0

gain @ s=∞ =0

band pass filter

4) In industry they use bode plots, specifically frequency domain to design and analyze analog filters to be used in closed-design systems. A common purpose would be in a power supply. This product requires great stability so close attention needs to be on the design and analysis of a filter. They test the system at several frequencies just like our bode plots, and analyze the resulting output that comes out of their system. This is similar to our bode plots. They analyze the difference in gain and phase shifting. They look at cross over frequency, phase margin, and gain margin. these give more insight into the stability of the system.