ECEN 325 – Electronics

Fall 2020

Lab 1: Prelab

Submitted by:

Student Name	UIN:	**Section #**
Michael Mengistu	12500724	**508**

1a.)

$$Z_{R_1} = R_1 \quad Z_{R_2} = R_2 \quad , \quad Z_{C_1} = \frac{1}{sC_1}$$

$$V_{LP} = \left(\frac{Z_{C_1} \| Z_{R_2}}{Z_{C_1} \| Z_{R_2} + Z_{R_1}} \right) V_i = \left(\frac{R_2}{C_1 R_1 R_2 s + R_1 + R_2} \right) V_i$$

$$H_{LP}(s) = \frac{V_{LP}}{V_i} = \frac{R_2}{C_1 R_1 R_2 s + R_1 + R_2} = K_L \frac{1}{1 + \frac{s}{\omega_L}}$$

$$\boxed{K_L = \frac{R_2}{R_1 + R_2}} \qquad \boxed{\omega_L = \left(\frac{C_1 R_1 R_2}{R_1 + R_2} \right)^{-1} = \frac{R_1 + R_2}{C_1 R_1 R_2}}$$

1b.)

$$Z_{C_2} = \frac{1}{sC_2} \quad Z_{R_3} = R_3 \quad Z_{C_3} = \frac{1}{sC_3}$$

$$V_{HP} = \left(\frac{Z_{C_2} \| Z_{R_3}}{Z_{C_3} \| Z_{R_3} + Z_{C_2}} \right) V_i = \left(\frac{C_2 R_3 s}{(C_2 + C_3) R_3 s + 1} \right) V_i$$

$$H_{HP}(s) = \frac{V_{HP}}{V_i} = \frac{C_2 R_3 s}{(C_2 + C_3) R_3 s + 1} = K_H \frac{s}{s + \omega_H}$$

$$\boxed{K_H = \frac{C_2 R_3}{(C_2 + C_3) R_3}}$$

$$\boxed{\omega_H = \frac{1}{(C_2 + C_3) R_3}}$$

2.)

$f_L = f_H = 5\,kHz$, $K_L = K_H = 0.5$, $\omega_L = \omega_H = 2\pi f_L = 10000\pi \frac{rad}{s}$

set $R_1 = 1000\Omega$

$$K_L = \frac{R_2}{R_1 + R_2} \Rightarrow 0.5 = \frac{R_2}{1000 + R_2} \Rightarrow \boxed{R_2 = 1000\Omega}$$

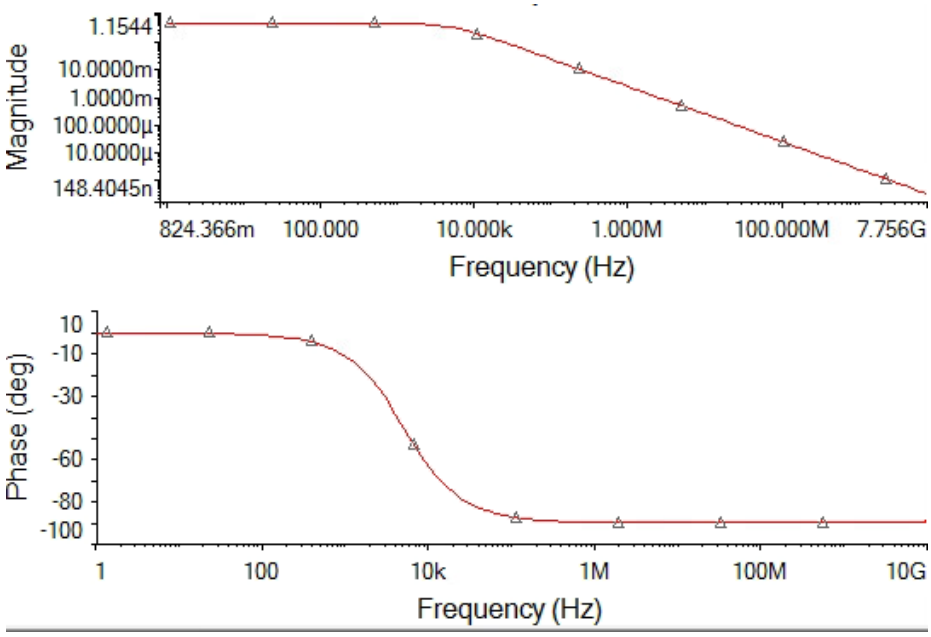
$$\omega_L = \frac{R_1 + R_2}{C_1 R_1 R_2} \Rightarrow 10000\pi = \frac{1000 + 1000}{C_1 (1000)(1000)} \Rightarrow \boxed{C_1 = 6.37 \times 10^{-8}\ F}$$

set $R_3 = 1000\Omega$

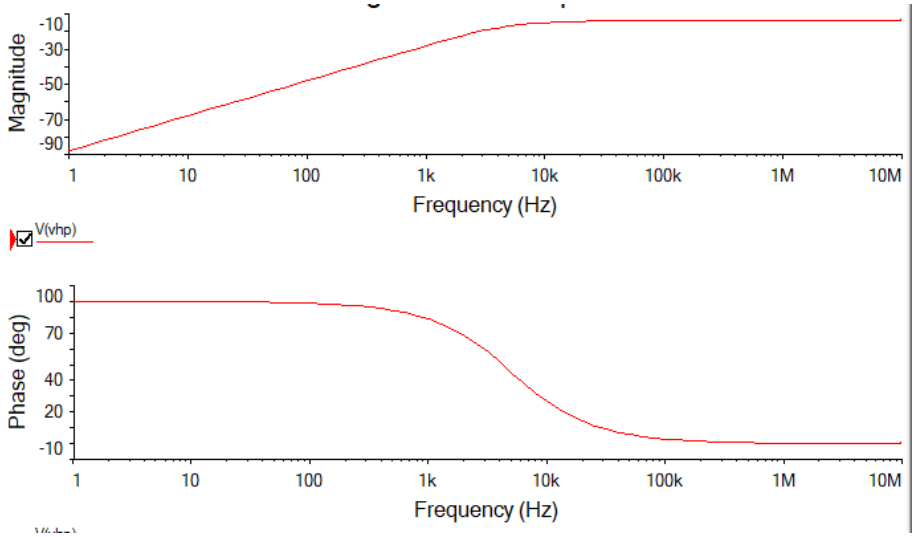
$$\begin{cases} K_H = \frac{C_2 R_3}{(C_2 + C_3) R_3} \\ \omega_H = \frac{1}{(C_2 + C_3) R_3} \end{cases} \Rightarrow \begin{cases} 0.5 = \frac{C_2 (1000)}{(C_2 + C_3)} \\ 10000\pi = \frac{1}{(C_2 + C_3)(1000)} \end{cases} \Rightarrow \boxed{C_2 = 1.59 \times 10^{-8}\ F} \quad \boxed{C_3 = 1.59 \times 10^{-8}\ F}$$

3.)

Circuit a bode plot



Circuit b bode plot



4.)

$$|H_{LP}(j\omega)| = \frac{1000}{\sqrt{0.0637(2\pi 4000))^2 + (2000)^2}} = 0.39 \qquad \text{magnitude} = 0.39 \times 0.4 = 0.156$$

$$\angle H_{LP}(j\omega) = -\tan\frac{2\pi 4000}{\omega_L} = \frac{2\pi 4000}{31397.2} = -1.03 \text{ rad}$$

$$V_{LP}(t) = 0.156 \sin(2\pi 4000t - 1.03)\,V$$

$$|H_{HP}(j\omega)| = \frac{1.59\times10^{-5}\,\omega}{\sqrt{(3.18\times10^{-5}\,\omega)^2 + 1}} = 0.312 \qquad \text{magnitude} = .3 \times .4 = 0.125$$

$$\angle H_{HP}(j\omega) = -\tan\frac{2\pi 4000}{\omega_{+1}} = -1.03 \text{ rad}$$

$$V_{HP}(t) = 0.125 \sin(2\pi 4000t - 1.03)\,V$$

5.)

$$|H_{LP}(j\omega)| = \frac{1000}{\sqrt{(0.0637\ (2\pi 6000))^2 + (2000)^2}} = 0.32$$

$$\angle H_{LP} = -\tan\frac{2\pi 6000}{\omega_L} = -2.58\,\text{rad}$$

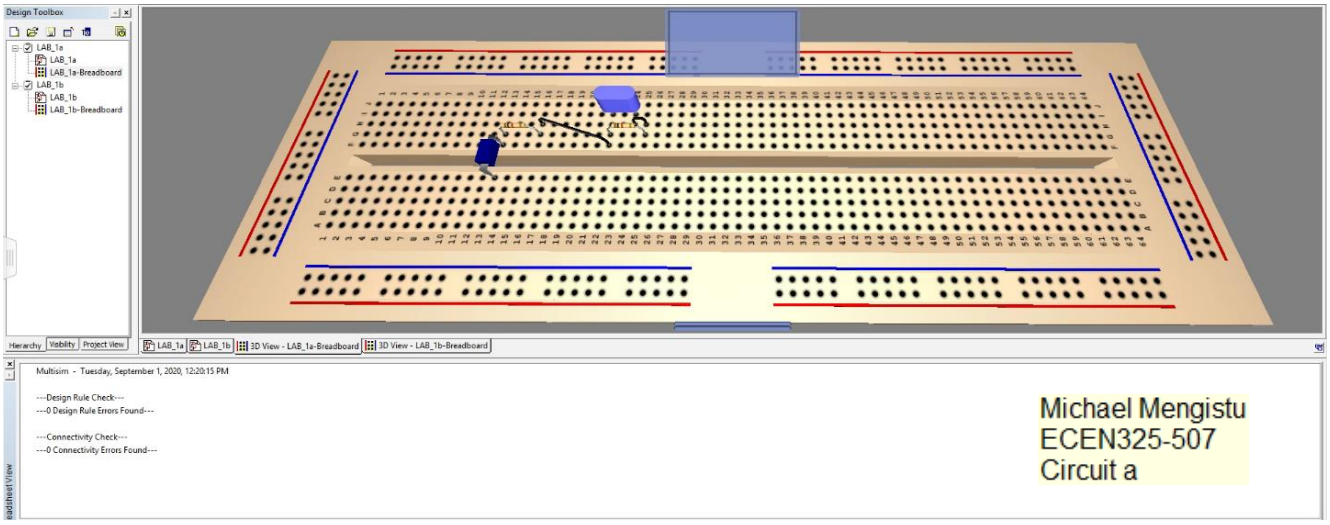
$$V_{LP}(t) = 0.096\sin(2\pi 6000t - 2.58)\,V$$

$$|H_{HP}(j\omega)| = \frac{1.59\times10^{-5}\omega}{\sqrt{(3.18\times10^{-5}\omega)^2 + 1}} = 0.384$$

$$\angle H_{HP}(j\omega) = -\tan\frac{2\pi 6000}{\omega_H} = -2.56\,\text{rad}$$

$$V_{HP}(t) = 0.115\sin(2\pi 6000t - 2.56)\,V$$

Circuit (a) breadboard



Circuit (b) breadboard