Lab #1

325 lab

Calculations

1)

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

$$\frac{\frac{R_2}{C_1 s}}{R_2 + \frac{1}{C_1 s}} = \frac{R_2}{C_1 R_2 s + 1}$$

$$\frac{V_{LP}}{V_i} = \frac{\frac{R_2}{C_1 R_2 s + 1}}{\frac{R_2}{C_1 R_2 s + 1} + R_1} = \frac{\frac{R_2}{C_1 R_2 s + 1}}{\frac{R_2 + R_1 + C_1 R_2 R_1 s}{C_1 R_2 s + 1}}$$

$$= \frac{R_2}{R_2 + R_1 + C_1 R_1 R_2 s} = \frac{1}{1 + \frac{R_1}{R_2} + s C_1 R_1} = \frac{1}{\left[\frac{R_1}{R_2} + 1\right] + R_1 C_1 s}$$

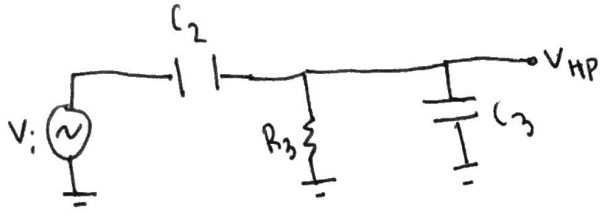
$$= \frac{1}{\left[\frac{R_1}{R_2} + 1\right]\left[1 + \frac{R_1 C_1 s}{\frac{R_1}{R_2} + 1}\right]}$$

$$K_L \cdot \frac{1}{1 + \frac{s}{\omega_L}} \qquad K_L = \frac{R_2}{R_1 + R_2}$$

$$\omega_L = \frac{R_1 + R_2}{R_1 R_2 C_1}$$

$$\frac{R_2}{R_1 + R_2} \cdot \frac{1}{1 + \frac{s}{\frac{R_1 + R_2}{R_1 R_2 C_1}\left(\frac{\frac{R_1}{R_2} + 1}{R_1 C_1}\right)}}$$

1)



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

$$\frac{\frac{1}{C_3 s} R_3}{R_3 + \frac{1}{C_3 s}} = \frac{R_3}{R_3 C_3 s + 1}$$

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

$$\frac{R_3 C_2 s}{R_3 C_3 s + 1 + R_3 C_2 s} = \frac{s}{s\frac{C_3}{C_2} + s + \frac{1}{R_3 C_2}} = \frac{s}{s\left[\frac{C_3}{C_2} + 1\right] + \frac{1}{R_3 C_2}}$$

$$= \frac{1}{\frac{C_3}{C_2} + 1} \cdot \frac{s}{s + \frac{1}{R_3 C_2} \cdot \frac{1}{\frac{C_3}{C_2} + 1}} = \boxed{\frac{C_2}{C_3 + C_2}\left[\frac{s}{s + \frac{C_2}{R_3 C_2 (C_3 + C_2)}}\right]}$$

where $K_H = \frac{C_2}{C_3 + C_2}$

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

2)

$$K_L = \frac{R_2}{R_1+R_2} = K_H = \frac{C_2}{C_3+C_2} = .5$$

$$\omega_L = \frac{\frac{R_1}{R_1}+1}{R_1 C_1} = \frac{R_1+R_2}{R_1 R_2 C_1} \qquad \omega_H = \frac{1}{R_3(C_3+C_2)}$$

$$\omega = 2\pi f \qquad f_L = f_H = 5K\,Hz$$

$$\omega_L = \omega_H = 2\pi(5000) = 10000\pi$$

~~$R_1 = R_2 = 1K\Omega$~~ → ~~$\omega_H = \frac{1000+1000}{(1000)(1000)C_1} = 10000\pi$~~

$$R_1 = R_2 = 1\,\Omega$$

$$\frac{1+1}{C_1} = 10000\pi$$

$$C_1 = 6.366\,E{-5}$$

$$\frac{C_2}{C_3+C_2} = .5 \qquad 2C_2 = C_3 + C_2$$

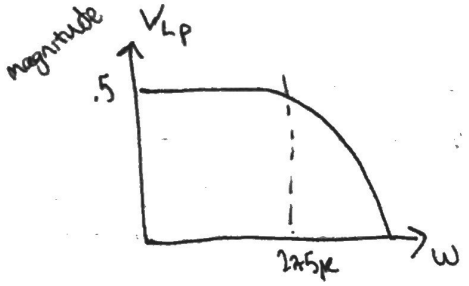
$$C_2 = C_3$$

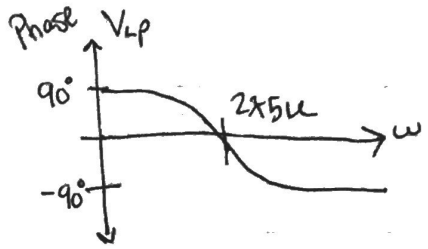
$$\omega_H = \frac{1}{(1)(C_3+C_2)} = 10000\pi$$

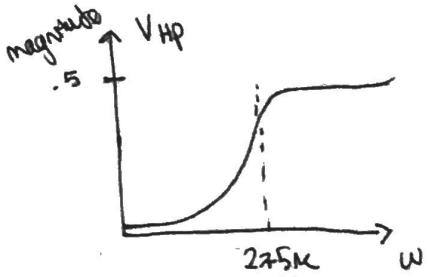
$R_3 = 1\,\Omega$

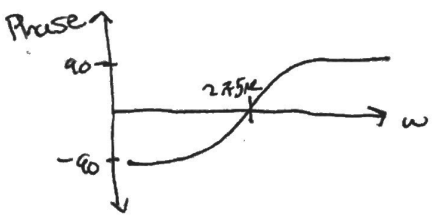
$$C_3 = C_2 = 1.5915\,E{-5}$$

3)









4) $V_i(t) = .4\sin(2\pi 4000t)$, $\omega = 2\pi 4000t$

$V_{LP} = .5 \dfrac{1}{1 + \frac{s}{2\pi 5k}}$

$|H(j\omega)| = (.5) \dfrac{1}{\sqrt{1 + \left(\frac{2\pi 4000}{2\pi 5000}\right)^2}} = \boxed{.3904}$

$\angle H(j\omega) = -\tan^{-1}(4/5) = \boxed{-.6747}$

$V_o(t) = .1561 \sin(2\pi 4000t - .6747)$

$|H(j\omega)| = (.5) \dfrac{j\omega}{j\omega + 2\pi 5k} (.4\sin(2\pi 4000t))$

$\dfrac{.5\, j4}{5 + j4} (.4\sin(2\pi 4k)) = \dfrac{2e^{j90}}{6.4030e^{38.65}} (.4\sin(2\pi 4k))$

$V_{out} = .125 \sin(2\pi 4k - .89622)$

5) $V_i = .3\sin(2\pi 6000t)$

$$|H(j\omega)| = .5\,\frac{1}{\sqrt{1+(6/5)^2}} = .32005$$

$$\angle H(j\omega) = -\tan^{-1}(6/5) = -.87$$

$$V_o(t) = .096\sin(2\pi 6000t - .87)$$

$$|H(j\omega)| = \frac{.5j6}{5+j6}\,.3\sin(2\pi 6000t) = \frac{j3}{5+j6}\,.3\sin(2\pi 6000t)$$

$$\frac{3e^{j90}}{7.8e^{j50.19}}\,.3\sin(2\pi 6000t) = .11523\sin(2\pi 6000t - .69473)$$