Rathamnoon Prakitpong #63205165

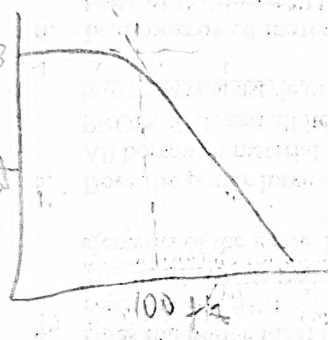
1. Just looks like non-inverting op-amp

DC gain = 11 = $\frac{1}{f}$ where $f = \frac{Z_1}{Z_2+Z_1}$

$\Rightarrow 11 = \frac{Z_2+Z_1}{Z_1} \rightarrow \boxed{10Z_1 = Z_2}$

2. from fig 3

108 dB from datasheet



$\boxed{BW = 100\,Hz}$

Since $G_{CL} = \frac{A}{1+AF}$, there's no change in general shape of bode plot, so BW is same for close loop & open loop case

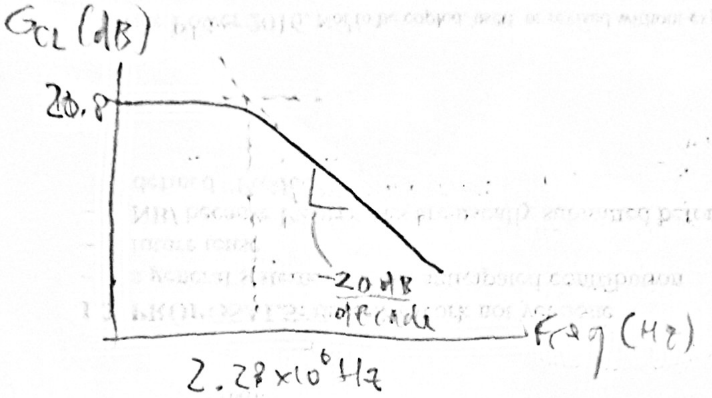
We can approximate transfer function for our relevant region (1~10K Hz) as:

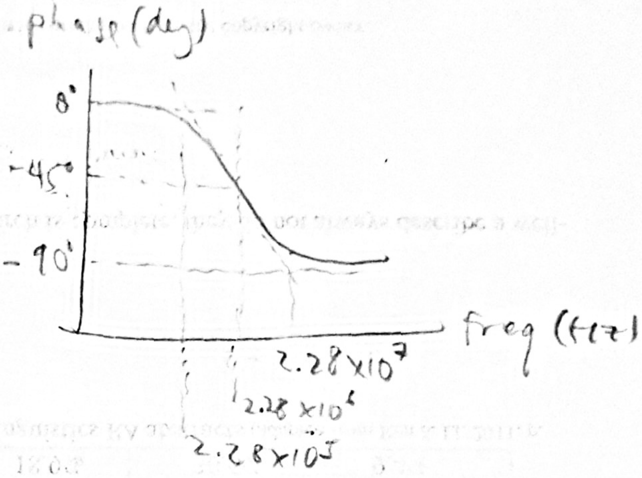
$$A_{OL}(s) = \frac{K}{1+\frac{s}{a}} = \frac{108\,dB}{1+\frac{s}{100}} = \frac{251189}{1+\frac{s}{100}}$$

$$\frac{V_o(s)}{V_i(s)} = G_{CL}(s) = \frac{A}{1+AF} = \frac{\frac{251189}{1+s/100}}{\frac{(1+s/100)+251189/11}{1+s/100}} = \frac{251189}{\left(1+\frac{251189}{11}\right)+\frac{s}{100}}$$

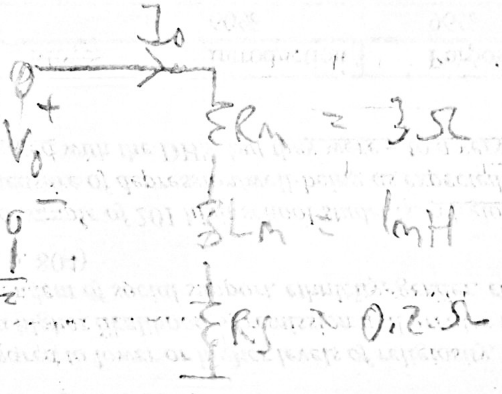
$$= \frac{\frac{251189(11)}{251200}}{1+s\left(\frac{11}{100(251200)}\right)} = \frac{11}{1+\frac{s}{2.28\times10^6}}$$

Note that $20\log_{10}(11) = 20.8$ dB





3.



$R_{sum} = 3.2\,\Omega = R_m + R_s$

$L_{sum} = 1mH = L_m$

$V_L(t) = L_m \frac{dI_0}{dt}$

$V_R(t) = R_{sum} I_0$

$V_0(t) = V_L(t) + V_R(t) = L_m \frac{dI_0}{dt} + R_{sum} I_0$

$V_0(s) = L_m(s I_0(s)) + R_{sum} I_0(s)$ [assume $I_0(0) \sim 0$ due to property of inductor]

$$\frac{I_0(s)}{V_0(s)} = \frac{1}{R_{sum} + sL_m}$$

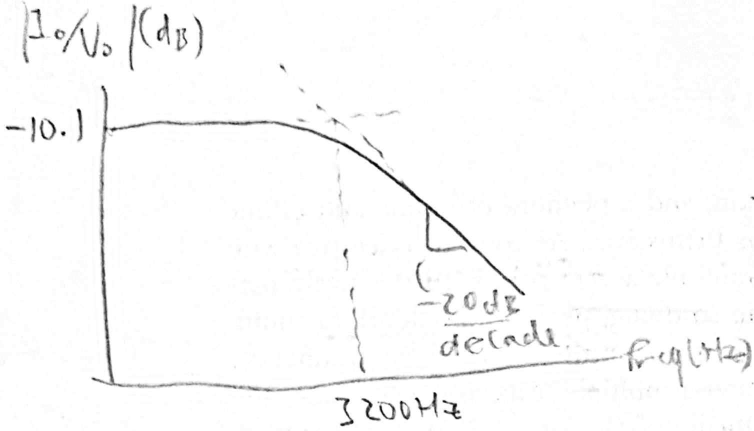
$$= \frac{1}{3.2 + 10^{-3}s}$$

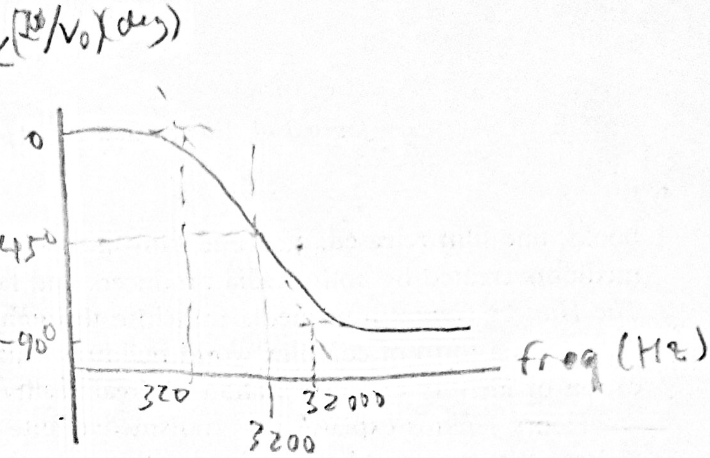
$\tau = 1/3200$

$$= \frac{1/3.2}{1 + s/(3.2/10^{-3})}$$

$$= \frac{1/3.2}{1 + s/3200}$$

Note that $20\log_{10}(1/3.2) = -10.1$ dB





4. $V_{I_0} = R_s I_0 \rightarrow R_s = \dfrac{V_{I_0}(s)}{I_0(s)}$

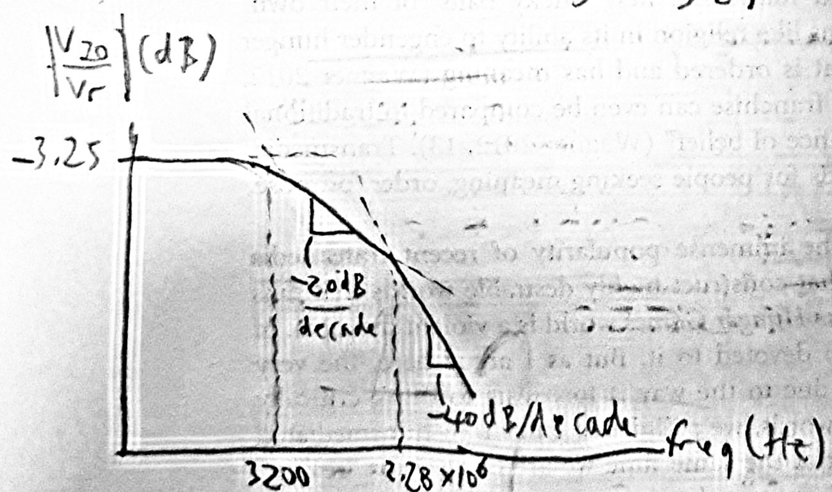
$$\frac{V_{I_0}(s)}{V_r(s)} = \left(R_s\right)\left(\frac{I_0(s)}{V_0(s)}\right)\left(\frac{V_0(s)}{V_r(s)}\right)$$

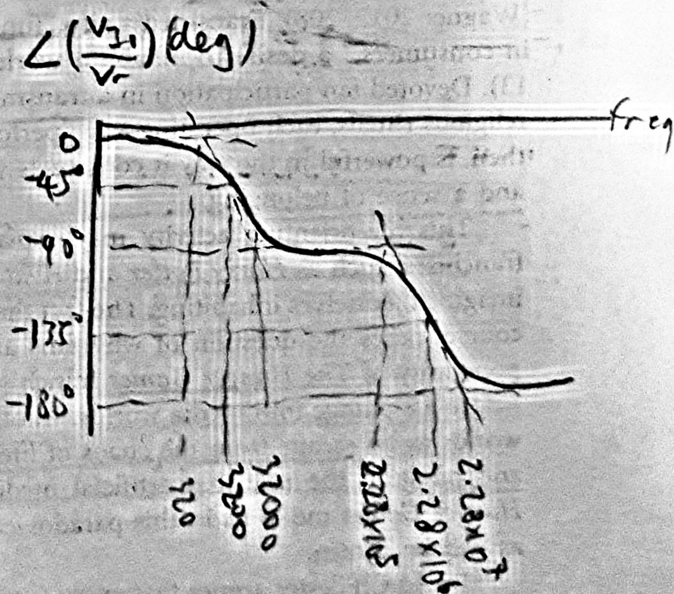
$$= R_s\left(\frac{1}{R_m+R_s+sL_m}\right)\left(\frac{A}{1+Af}\right)$$

$$= 0.2\left(\frac{1/3.2}{1+s/3200}\right)\left(\frac{11}{1+s/(2.28\times10^6)}\right)$$

$$= (2.2/3.2)\left(\frac{1}{1+s/3200}\right)\left(\frac{1}{1+s/(2.28\times10^6)}\right)$$

Note that $20\log_{10}\left(\frac{2.2}{3.2}\right) = -3.25$ dB





Get step response from MATLAB