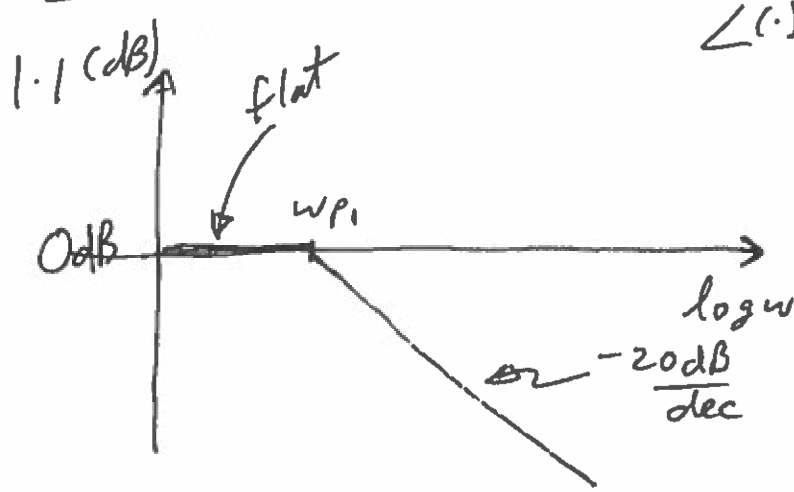
Bode Approximation Example #1

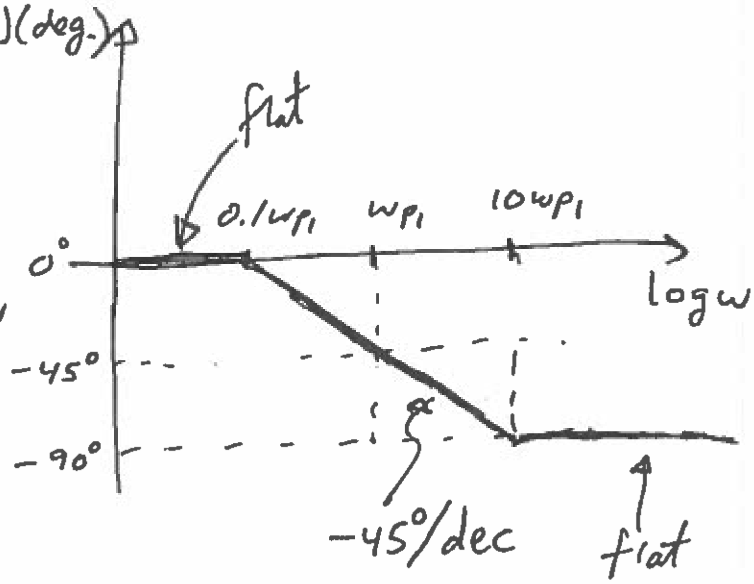
$$H = \frac{V_{out}}{V_{in}} = \frac{R_2 + \frac{1}{sC_1}}{R_2 + \frac{1}{sC_1} + R_1} = \frac{1 + sR_2C_1}{1 + s(R_1+R_2)C_1}$$

$$\Rightarrow H(s) = \frac{1 + s/\omega_{z_1}}{1 + s/\omega_{p_1}}, \quad \boxed{\omega_{z_1} = \frac{1}{(R_2C_1)}}, \quad \boxed{\omega_{p_1} = \frac{1}{(R_1+R_2)C_1}}$$

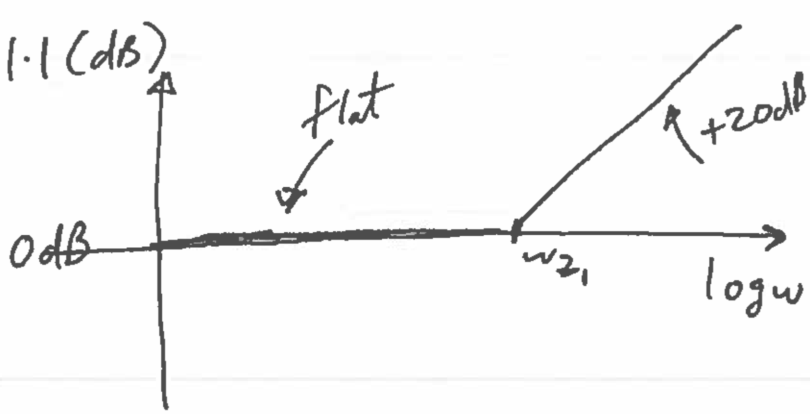
$\Rightarrow$ and we observe that $\underline{\omega_{p_1} < \omega_{z_1}}$

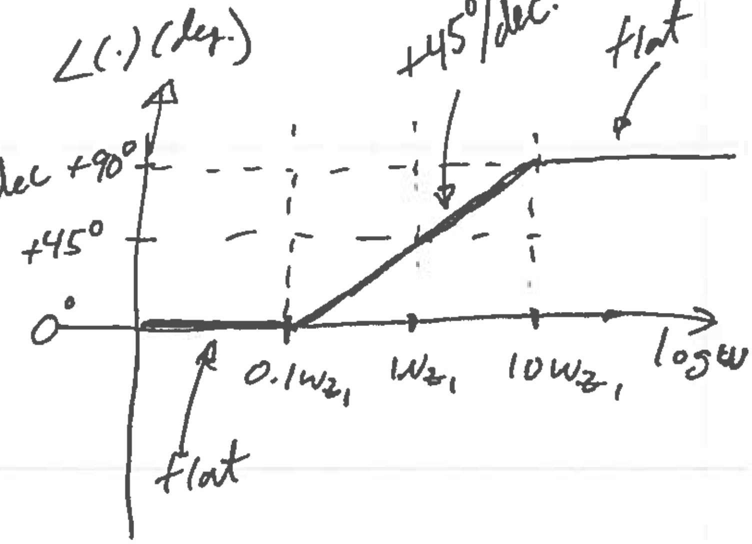
I) pole @ ω_{p_1} : $\frac{1}{(1+s/\omega_{p_1})}$





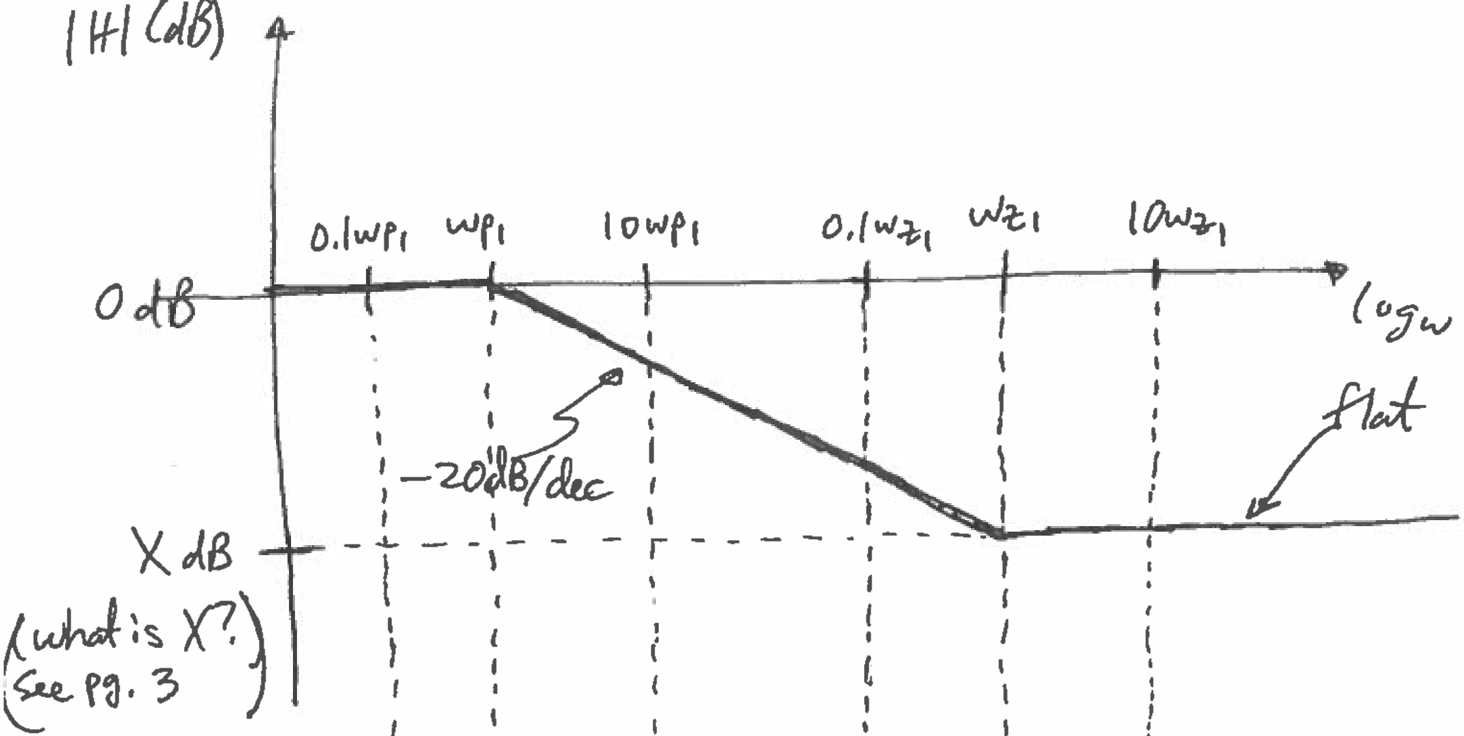
II) zero @ ω_{z_1} : $\frac{(1+s/\omega_{z_1})}{1}$

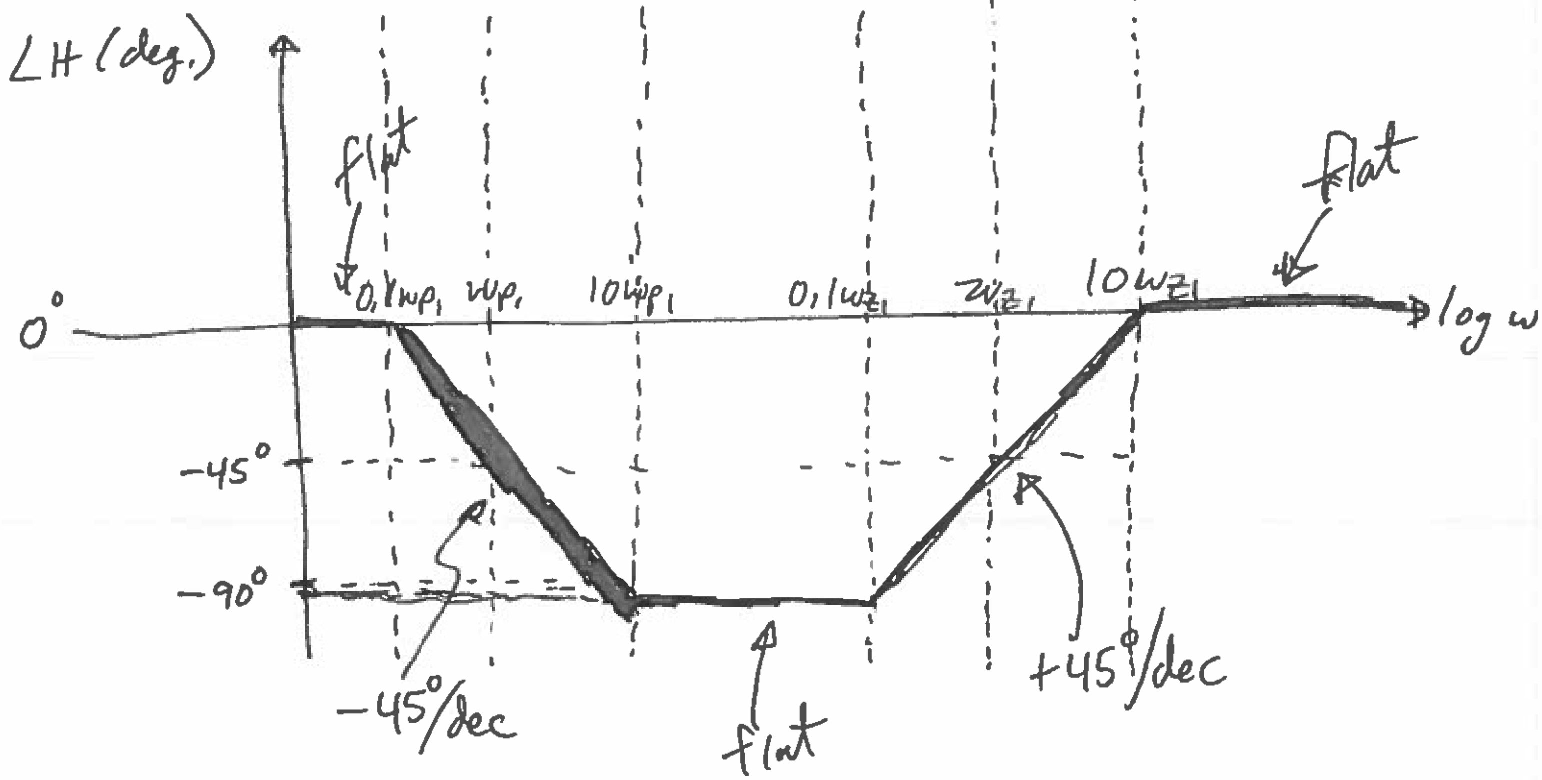




$\Rightarrow$ Now, we need to combine ("add up") the two individual responses from (I) & (II) to get the total response. $\rightarrow$

Bode approximation of $H = \frac{1+s/w_{z1}}{1+s/w_{p1}}$ (Recall that $w_{p1} < w_{z1}$)





To find X (dB):

1) @ w_{p1}, we know the approximation tells us that $|H| = 0\,dB \overset{set}{=} Y\,dB$

2) The slope beyond w_{p1} is $-20\,dB/dec$. We need to find how many decades there are between w_{p1} and w_{z1}.

$\Rightarrow$ # of decades between W_{p1} and w_{z1} $= X_{dec} = \log_{10}\left(\frac{w_{z1}}{w_{p1}}\right)$
(always put the larger frequency in the numerator ↗)

$$X_{dec} = \log_{10}\left(\frac{1/(R_2C_1)}{1/[(R_1+R_2)C_1]}\right) = \log_{10}\left(\frac{R_1+R_2}{R_2}\right) = -\log_{10}\left(\frac{R_2}{R_1+R_2}\right)$$

So, $$X\,dB = Y\,dB + (-20\,dB/dec)\,X\,dec$$

$$X\,dB = 0\,dB + 20\log_{10}\left(\frac{R_2}{R_1+R_2}\right)$$

$$\Rightarrow \boxed{X\,dB = 20\log_{10}\left(\frac{R_2}{R_1+R_2}\right)}$$