Analog Electronics

QUIZ # 4.2

(a) i) $f_T = \dfrac{g_m}{2\pi(C_{gs}+C_{gd})} = \dfrac{2\times10^{-3}}{2\pi(5+2)\times10^{-12}} \simeq 45.48^{MHz}$

ii) $C_{eq} = (1+g_m R_L')C_{gd}$ $\quad (R_D // R_L = 5^{k\Omega}$

$= (1+2\times10^{-3}\times 5\times10^{3})2$

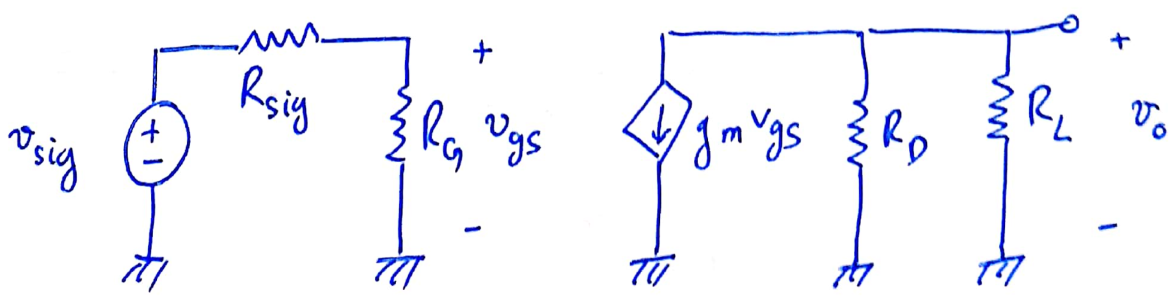
$= 22\ pF$

iii) $f_H = \dfrac{1}{2\pi C_{in} R_{sig}'} = \dfrac{1}{2\pi(C_{gs}+C_{eq})R_{sig}'}$

$= \dfrac{1}{2\pi(5+22)^{pF}\times 49.18^{k\Omega}}$ $\quad (R_{sig}' = R_{sig}//R_G = 49.18^{k\Omega},$

$\simeq 120\ kHz$

iv) $A_M = \dfrac{v_o}{v_{sig}} = -g_m \dfrac{R_G}{R_G+R_{sig}} R_D // R_L \simeq -10$

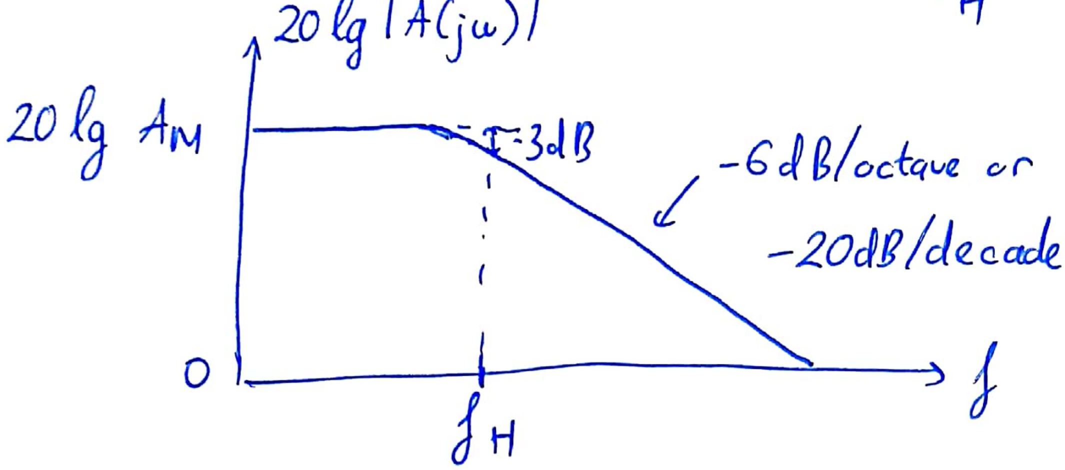


v) $-6dB$/octave means that at $2f_H$ the gain is:

$20\lg|A_M| - 6dB = 20\log 10 - 6 = 14 dB$

$\Rightarrow A_{2f_H} = 10^{14/20} \simeq 5$

(vi) $A(j\omega) = \dfrac{v_o(j\omega)}{v_{sig}(j\omega)} = -A_M \dfrac{1}{1 + j\dfrac{\omega}{\omega_H}}$



(b) i) $f_T = \dfrac{g_m}{2\pi(C_\pi + C_\mu)}$ $\begin{cases} g_m = I_c / V_T = 1/25 = 0.04 \,^{A/V} \\ C_\pi + C_\mu = 20 + 5 = 25 \,^{pF} \end{cases}$

$\simeq 255\ MHz$

ii) $g_m = \dfrac{I_c}{V_T} = \dfrac{1}{25} = 0.04\ (A/V)$

$R_L' = R_L \,//\, R_c = 2.5\ (k\Omega)$

$C_{eq} = (1 + g_m R_L')C_\mu = (1 + 0.04 \times 2500)5^{pF}$

$= 505\ (pF)$

iii) $R_{sig}' = r_\pi \,//\, [r_x + (R_B \,//\, R_{sig})] = 2.5 \,//\, [0.05 + 82 \,//\, 2] \simeq 1.1^{k\Omega}$

$(r_\pi = \beta / g_m = 100 / 0.04 = 2.5^{k\Omega})$

$f_H = \dfrac{1}{2\pi C_{in} R_{sig}'} = \dfrac{1}{2\pi \times 525^{pF} \times 1.1^{k\Omega}} \simeq 276\ (kHz)$

$(C_{in} = C_\pi + C_{eq} = 20 + 505 = 525\ pF)$

iv) $$\frac{v_o}{v_{sig}} = \frac{-R_B}{R_{sig}+R_B} \cdot \frac{r_\pi}{r_\pi + r_x + R_B /\!/ R_{sig}} \, g_m R_L'$$

$$= \frac{-82}{2+82} \cdot \frac{2.5}{2.5+0.05+2/\!/82} \, 0.04 \times 2500$$

$A_M \simeq -55$

$A_M(dB) = 20 \log |-55| \simeq 34.8 \text{ dB}$

v) Bode plot.