# Analog Electronics

## QUIZ #4.1

ⓐ (i) $f_{P2} = \dfrac{1}{2\pi (C_S / g_m)} = f_L \iff C_S = \dfrac{g_m}{2\pi f_L} = \dfrac{10^{-3}}{2\pi \times 200}$

$C_S \simeq 8 \times 10^{-7} (F) = 0.8^{\mu F}$

(ii) $f_{P1} = 20\,Hz \iff \dfrac{1}{2\pi C_{C1} (R_G + R_{sig})} = 20$

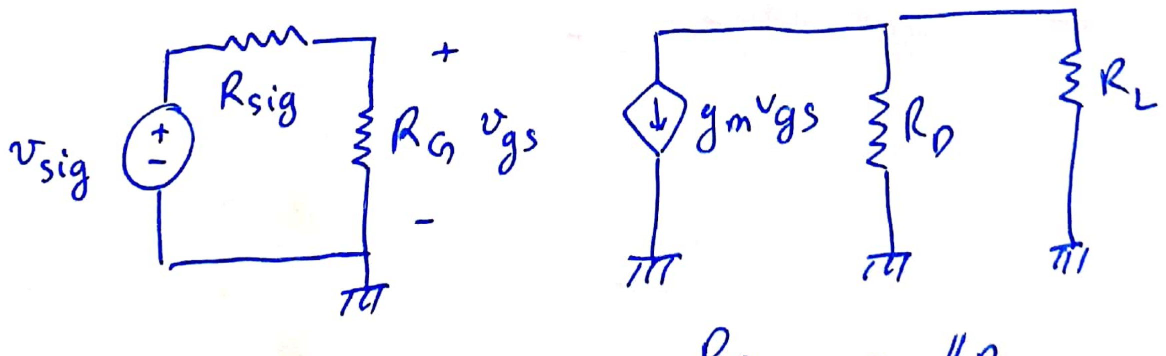
$\iff R_G + R_{sig} = \dfrac{1}{40\pi \times 2.7 \times 10^{-9}} \simeq 2.947\,M\Omega$

$\iff R_G = 2.947^{M\Omega} - 50^{k\Omega} \simeq 2.9^{M\Omega}$

$f_{P3} = 20^{Hz} \iff \dfrac{1}{2\pi C_{C_2} (R_D + R_L)} = 20$

$\iff C_{C_2} = \dfrac{1}{40\pi (2 \times 10^4)} \simeq 0.4^{\mu F}$

(iii) Use $\pi$-model




$v_o = -g_m v_{gs} R_D // R_L = -g_m \dfrac{R_G}{R_{sig} + R_G} R_D // R_L$

$A_v = \dfrac{v_o}{v_{sig}} \simeq -g_m R_D // R_L = -10^{-3} \times 5 \times 10^3 = -5$

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(b) $g_m = \frac{I_C}{V_T} = \frac{1^{mA}}{25^{mV}} = 0.04 (A/V)$

$r_\pi = \frac{25^{mV}}{I_B} = \frac{25}{0.01} = 2.5^{k\Omega}$

$r_e = \frac{r_\pi}{\beta + 1} \simeq 25^{\Omega}$

(i) Looking at $C_E$:

$R_E = r_e + \frac{R_B // R_{sig}}{\beta + 1} = 25 + \frac{82^k // 2^k}{101} \simeq 44^{\Omega}$

$\omega_{P2} = \frac{1}{R_E C_E} = 2\pi f_L \times 80\%$

$\Leftrightarrow f_L = \frac{1}{2\pi \times 0.8 \times R_E C_E} \simeq 205^{Hz}$

(ii) Looking at $C_{C1}$:

$R_{C1} = R_B // r_\pi + R_{sig} = 82^k // 2.5^k + 2^k = 4.42^{k\Omega}$

$\Rightarrow \frac{1}{R_{C1} C_{C1}} = \omega_{P1} = 10\% \, 2\pi f_L$

$\Leftrightarrow C_{C1} = \frac{1}{0.1 R_{C1} 2\pi f_L} \simeq 1.75^{\mu F}$

Looking at $C_{C2}$:

$R_{C2} = R_L + R_C = 10^{k\Omega}$

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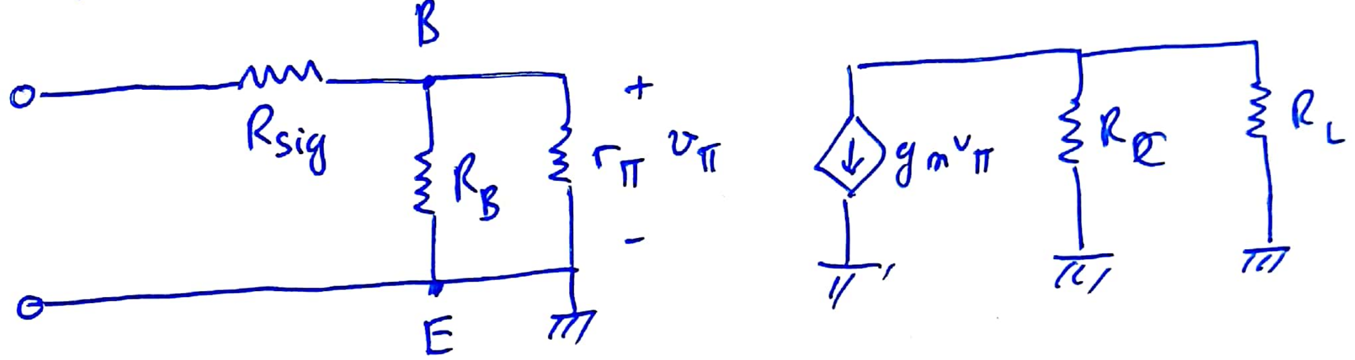
$$\omega_{P3} = \frac{1}{C_{C2} R_{C2}} = 10\% \, 2\pi f_L$$

$$\Leftrightarrow C_{C_2} = \frac{1}{10^4 \times 0.1 \times 2\pi \times 205} \simeq 0.77 \, \mu F$$

iii) All capacitors short-circuited.

$\pi$ - model:




$$v_o = -v_{sig} \frac{R_B // r_\pi}{R_B // r_\pi + R_{sig}} g_m R_C // R_L$$

$$\Leftrightarrow A_v = -0.04 \times 2500 \times \frac{2426}{2426 + 2000} \simeq -54$$

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