전자회로 2차 과제

과목명	전자회로[A]
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1.
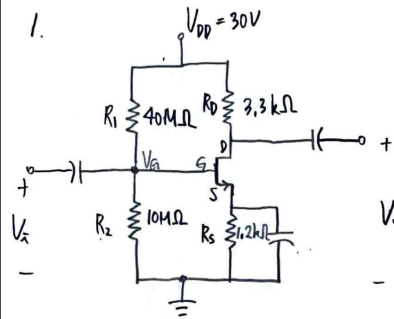
$V_{TH} = 3[V]$, $\quad k_n = \mu_n C_{ox} \dfrac{W}{L} = 0.4 \times 10^{-3} [A/V^2]$

① DC 분석

$$V_G = V_{DD} \times \frac{R_2}{R_1 + R_2} = 30 \times \frac{10M}{40M + 10M} = 30 \times \frac{1}{5} = 6 [V]$$

$$V_{GS} = V_G - I_S R_S = V_G - I_D R_S = 6 - 1.2 \times 10^3 I_D [V]$$

$I_D = \dfrac{k_n}{2} (V_{GS} - V_{TH})^2$ 으로부터, $\quad I_D = \dfrac{0.4 \times 10^{-3}}{2} (6 - 1.2 \times 10^3 I_D - 3)^2$

$$5000 I_D = (3 - 1.2 \times 10^3 I_D)^2$$

$$5000 I_D = 9 - 7200 I_D + 1440000 I_D^2$$

$$0 = 1440000 I_D^2 - 12200 I_D + 9$$

$I_D = 0.007656$ or 0.0008164, $\quad \therefore I_D = 0.8164 [mA]$

$$V_{GS} = 6 - 1.2 \times 10^3 I_D = 6 - 1.2 \times 10^3 \times 0.8164 \times 10^{-3} = 5.0203 [V]$$
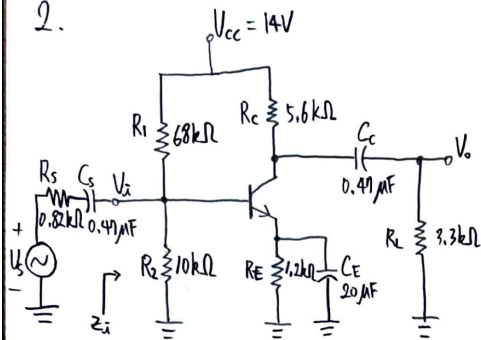
② 소신호 분석

$g_m = k_n (V_{GS} - V_{TH}) = 0.4 \times 10^{-3} (5.0203 - 3) = 0.0008081 = 0.8081 [mS]$

(1) $A_v = -g_m R_D = -0.8081 \times 10^{-3} \times 3.3 \times 10^3 = -2.6667$

(2) $Z_i = R_1 \| R_2 = \dfrac{40M \times 10M}{40M + 10M} = \dfrac{400}{50} M = 8 [M\Omega]$

(3) $Z_o = R_D = 3.3 [k\Omega]$

2.

$C_{Wi} = 5\ [pF]$ $C_{bc} = 12\ [pF]$

$C_{Wo} = 8\ [pF]$ $C_{be} = 40\ [pF]$ $\beta = 120$

$C_{ce} = 8\ [pF]$

(1) DC 분석

$V_{BB} = V_{cc} \times \dfrac{R_2}{R_1 + R_2} = 14 \times \dfrac{10k}{68k + 10k} = 1.7949\ [V]$

$R_B = R_1 // R_2 = \dfrac{68k \times 10k}{68k + 10k} = 8.7179\ [k\Omega]$

$I_B = \dfrac{V_{BB} - V_{BE}}{R_B + (\beta+1) R_E} = \dfrac{1.7949 - 0.7}{8.7179k + 121 \times 1.2k} = 7.1135 \times 10^{-6} = 0.0071\ [mA]$

$I_c = \beta I_B = 120 \times 0.0071\ m = 0.852\ [mA]$, $g_m = \dfrac{I_c}{V_T} = \dfrac{0.852m}{26m} = \underline{0.0328\ [S]}$

$r_\pi = \dfrac{\beta}{g_m} = \dfrac{120}{0.0328} = 3.6585\ [k\Omega]$, $A_{VL} = -g_m (R_c // R_L) = -68.1061$

(2) 저주파 분석

$f_{LS} = \dfrac{1}{2\pi (R_s + R_1 // R_2 // r_\pi) C_s}$

$= \dfrac{1}{2\pi (0.82k + 68k // 10k // 3.6585k) \times 0.47\mu}$

$= \dfrac{1}{2\pi (0.82k + 2.5770k) \times 0.47\mu}$

$= 99.6843\ [Hz]$

$f_{LC} = \dfrac{1}{2\pi (R_c + R_L) C_c} = \dfrac{1}{2\pi (5.6k + 3.3k) \times 0.47\mu}$

$= 38.0480\ [Hz]$

$f_{LE} = \dfrac{1}{2\pi \left\{ R_E // \left(\dfrac{R_s // R_1 // R_2}{\beta+1} + \dfrac{1}{g_m} \right) \right\} C_E}$

$= \dfrac{1}{2\pi \left\{ 1.2k // \left(\dfrac{0.82k // 68k // 10k}{121} + \dfrac{1}{0.0328} \right) \right\} \times 20\mu}$

$= \dfrac{1}{2\pi \left\{ 1.2k // (6.1942 + 30.4878) \right\} \times 20\mu} = \dfrac{1}{2\pi \times 35.5940 \times 20\mu}$

$= 223.5699\ [Hz]$

$Max(f_{LS}, f_{LC}, f_{LE}) = \underline{223.5699\ [Hz]} \leftarrow$ 하위차단주파수

(3) 고주파 분석

[입력단] $R_{Hi} = R_s // R_1 // R_2 // r_\pi = 0.82k // 68k // 10k // 3.6585k$

$= 0.8102k // 10k // 3.6585k = 0.7495k // 3.6585k = 0.6221\ [k\Omega]$

$C_{Hi} = C_{Wi} + C_\pi + (1 - A_{VL}) C_\mu = 5p + 40p + (1 + 68.1061) \times 12p$

$= 874.2732\ [pF]$

$\therefore f_{Hi} = \dfrac{1}{2\pi R_{Hi} C_{Hi}} = 292.6259\ [kHz]$

[출력단] $R_{HO} = R_c // R_L = 5.6k // 3.3k = 2.0764\ [k\Omega]$

$C_{HO} = C_{Wo} + C_{ce} + \left(1 - \dfrac{1}{A_{VL}} \right) C_{bc} = 8p + 8p + \left(1 + \dfrac{1}{68.1061} \right) \times 12p$

$= 28.1762\ [pF]$

$\therefore f_{HO} = \dfrac{1}{2\pi R_{HO} C_{HO}} = 2.7204\ [MHz]$

[β의 영향]

$f_\beta = \dfrac{1}{2\pi r_\pi (C_\pi + C_\mu)} = \dfrac{1}{2\pi \times 3.6585k \times (40p + 12p)}$

$= 836.5920\ [kHz]$

$Min(f_{Hi}, f_{HO}, f_\beta) = \underline{292.6259\ [kHz]}$

↑

상위차단주파수