3η Σειρά Ασκήσεων Ηλεκτρονική ΙΙ

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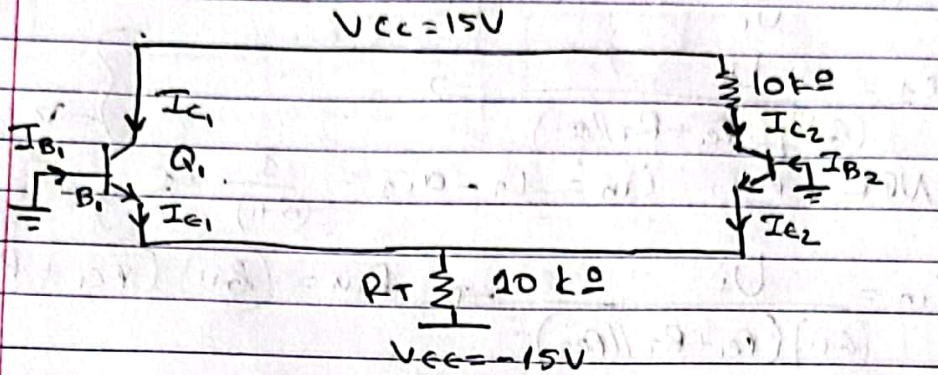
Άσκηση 1

DC ανάλυση:



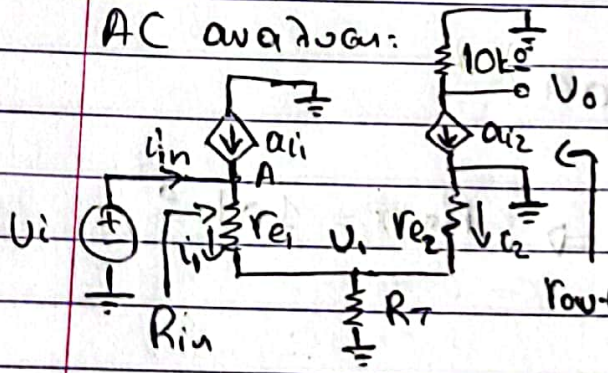
$$\left.\begin{array}{l} V_{BE_1} = V_{BE_2} = 0{,}7V \\ V_{B_1} - V_{E_1} = 0{,}7\ V \\ V_{B_2} - V_{E_2} = 0{,}7\ V \end{array}\right\} \Rightarrow V_{E_1} = V_{E_2} = -0{,}7\ V$$

$I_{E_1} = \frac{1}{2} I_{R_T}$ $\quad I_{E_1} = \dfrac{V_{E_1} - V_{EE}}{2 \cdot 10^4} = \dfrac{14{,}3}{2 \cdot 10^4} = 0{,}715\ mA$

$$I_{C_1} = \frac{b}{b+1} I_{E_1} = 0{,}708\ mA$$

$$I_{C_1} = I_{C_2} = 0{,}708\ mA$$

AC ανάλυση:



$$U_1 = \frac{R_T // r_{e_2}}{R_T // r_{e_2} + r_{e_1}} U_i$$

Από διαιρέτη τάσης

$$i_2 = \frac{0 - U_1}{r_{e_2}} = -\frac{U_1}{r_{e_2}}$$

$$0 - V_o = a i_2\, 10 \cdot 10^3 \Rightarrow V_o = -a i_2\, 10^4 = -a\left(-\frac{U_1}{r_{e_2}}\right) \cdot 10^4 = \frac{a U_1}{r_{e_2}} 10^4$$

$$V_o = \frac{a \cdot 10^4}{r_{e_2}} \cdot \frac{R_T // r_{e_2}}{R_T // r_{e_2} + r_{e_1}} U_i \Rightarrow \frac{V_o}{U_i} = \frac{(a \cdot 10^4)(R_T // r_{e_2})}{r_{e_2}(R_T // r_{e_2} + r_{e_1})}$$

Έχω $r_{e1} = \frac{V_T}{I_{E1}} = \frac{25mV}{0,715mA} \simeq 35\Omega = r_{e2}$

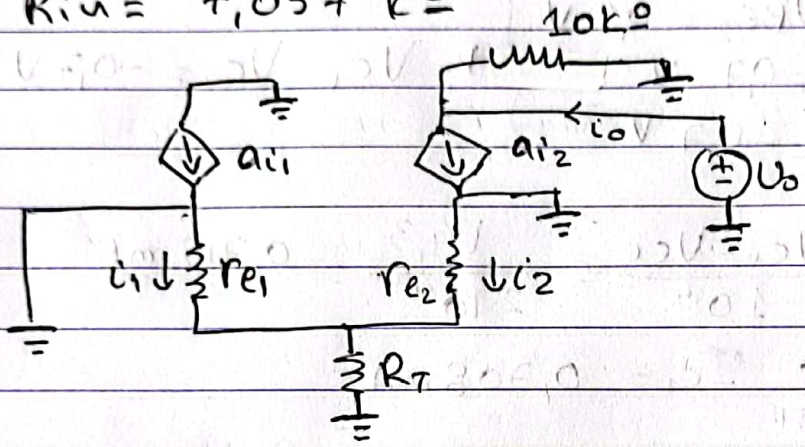
Άρα $\frac{U_o}{U_i} = 141,2$ V/V

$$i_1 = \frac{U_i}{(\beta+1)(r_{e1} + R_T // r_{e2})}$$

ΝΡΚ Α $\quad i_{in} = i_1 - \alpha i_1 = \frac{1}{(\beta+1)} i_1$ $\Rightarrow$

$$i_{in} = \frac{U_i}{(\beta+1)(r_{e1} + R_T // r_{e2})} \Rightarrow R_{in} = (\beta+1)(r_{e1} + R_T // r_{e2})$$

$R_{in} = 7,057\ k\Omega$



Για την Rout εφαρμόζω Uo στην έξοδο και μηδενίζω την είσοδο.

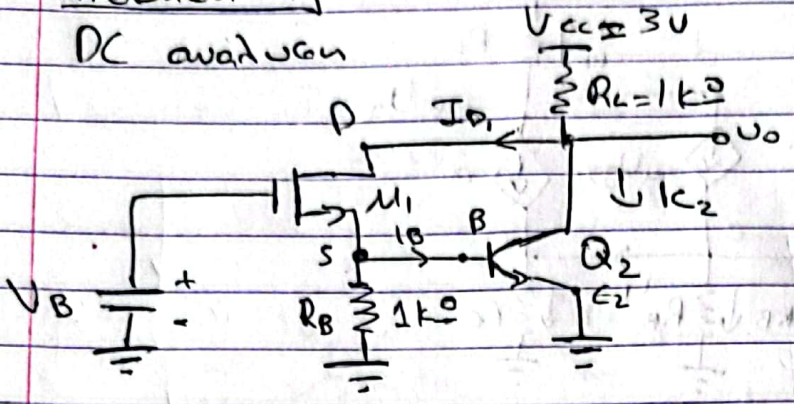
$$i_1 = \frac{0-0}{r_{e1} + R_T // r_{e2}} \Rightarrow i_1 = 0\ A$$

$$i_2 = \frac{0-0}{r_{e2} + R_T // r_{e1}} \Rightarrow i_2 = 0\ A$$

Άρα $i_o = \frac{U_o - 0}{10k\Omega} \Rightarrow R_{out} = 10k\Omega$

Άσκηση 2

DC ανάλυση



$V_o = 2V \rightarrow I_{RL} = \frac{3-2}{10^3} = 1mA$

ΝΡΚ στο C $\Rightarrow I_{C_2} + I_{D_1} = I_{RL}$ (1)

$V_{B_1} - V_{C_1} = 0,7 \Rightarrow V_{B_1} = 0,7V$

$I_{R_B} = \frac{V_B}{R_B} = 0,7mA$

$I_{B_2} = I_{D_1} - I_{R_B} = I_{D_1} - 0,7$

$I_{C_2} = \beta I_{B_2} \Rightarrow I_{C_2} = \beta(I_{D_1} - 0,7)$ (1) $\Rightarrow$

$I_{C_2} = \beta(1 - I_{C_2} - 0,7) = \beta(0,3 - I_{C_2}) \Rightarrow \frac{I_{C_2}}{\beta} + I_{C_2} = 0,3$

$I_{C_2} = 0,297mA \Rightarrow I_{D_2} = 1 - 0,297 \Rightarrow I_{D_1} = 0,703mA$

$I_{D_1} = \frac{1}{2} k' \frac{W}{L} V_{ov}^2 \Rightarrow V_{ov}^2 = 0,0545V^2$

$V_{ov} = 0,233V \Rightarrow V_{GS} - V_t = 0,233 \Rightarrow V_{GS} = 0,5409V$

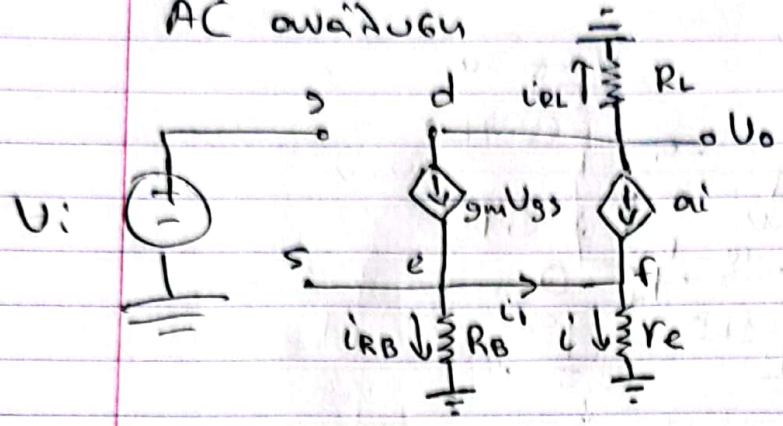
$V_B - V_S = 0,5409 \Rightarrow$

$\boxed{V_B = 1,2409V}$ $\boxed{I_{D_1} = 0,703mA}$ $\boxed{I_{C_2} = 0,297mA}$

$\boxed{I_{B_2} = 2,97\mu A}$

Άρα $\boxed{I_{C_1} = 299,97\mu A}$

AC ανάλυση



ΝΡΚ στον f:

$$i_1 + \alpha i = i \Rightarrow i_1 = \frac{1}{\beta+1} i = \frac{V_B}{(\beta+1) r_e}$$

ΝΡΚ στον e:

$$-i_1 + g_m V_{gs} = i_{RB} \Rightarrow g_m (V_i - V_s) - \frac{V_s}{(\beta+1) r_e} = \frac{V_s}{R_B}$$

$$\Rightarrow V_s \left(\frac{1}{R_B} + g_m + \frac{1}{(\beta+1) r_e} \right) = g_m V_i$$

$$V_s = \frac{g_m}{g_m + \frac{1}{R_B} + \frac{1}{(\beta+1) r_e}} V_i \Rightarrow \alpha i = \frac{\alpha V_s}{r_e} = \frac{\alpha}{\left(g_m + \frac{1}{R_B} + \frac{1}{(\beta+1) r_e} \right) r_e} \cdot g_m V_i$$

ΝΡΚ στον d:

$$i_{RL} = -(g_m V_{gs} + \alpha i) \Rightarrow$$

$$i_{RL} = - \frac{\frac{\alpha}{r_e} + \frac{1}{R_B} + \frac{1}{(\beta+1) r_e}}{g_m + \frac{1}{R_B} + \frac{1}{(\beta+1) r_e}} g_m V_i \quad \text{και} \quad i_{RL} = \frac{V_o}{R_L}$$

$$\frac{V_o}{V_i} = \frac{-g_m R_L \left(\frac{\alpha}{r_e} + \frac{1}{R_B} + \frac{1}{(\beta+1) r_e} \right)}{g_m + \frac{1}{R_B} + \frac{1}{(\beta+1) r_e}}$$

$$g_m = \frac{2 I_D}{V_{OV}} = 6{,}03 \text{ mA/V} \qquad r_e = \frac{V_T}{I_E} = 83{,}33 \Omega$$

Άρα $\frac{V_o}{V_i} = -10{,}97 \text{ V/V}$