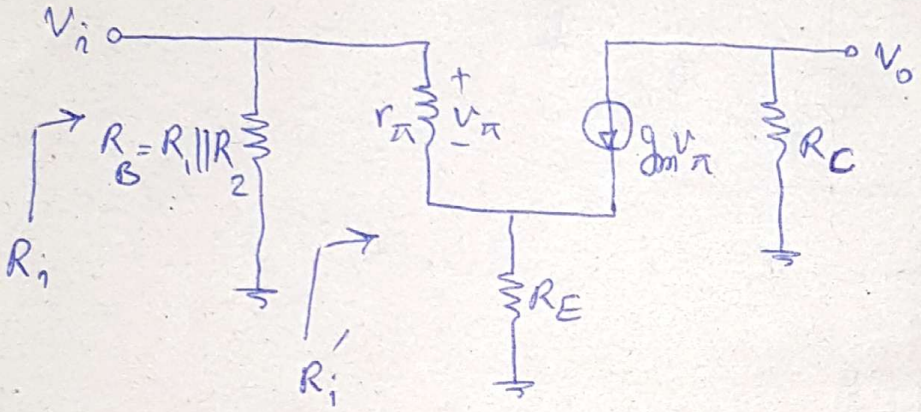
۱) با تحلیل DC مدار مقدار I_C برابر است با:

$$I_C = 813\,\mu A$$

که نتیجه می شود:

$$r_\pi = 3.1\,k\Omega\,,\quad g_m = 32.5\,mS$$

مدار معادل AC به صورت زیر است.



$$A_v = \frac{V_o}{V_i} = -\frac{R_C}{R_E + \frac{r_\pi}{\beta}} = -16.9$$

$$R_i' = r_\pi + \beta R_E \Longrightarrow R_i = R_B \| R_i' = 3.6\,k\Omega$$

$$r_o = 86.1\,k\Omega$$

با $V_A = 70\,V$ خواهیم داشت:

$$R_o' = r_o\left[1 + \frac{\beta R_E}{r_\pi + R_S + R_E}\right] \Longrightarrow R_o = R_o' \| R_C = 3.9\,k\Omega$$

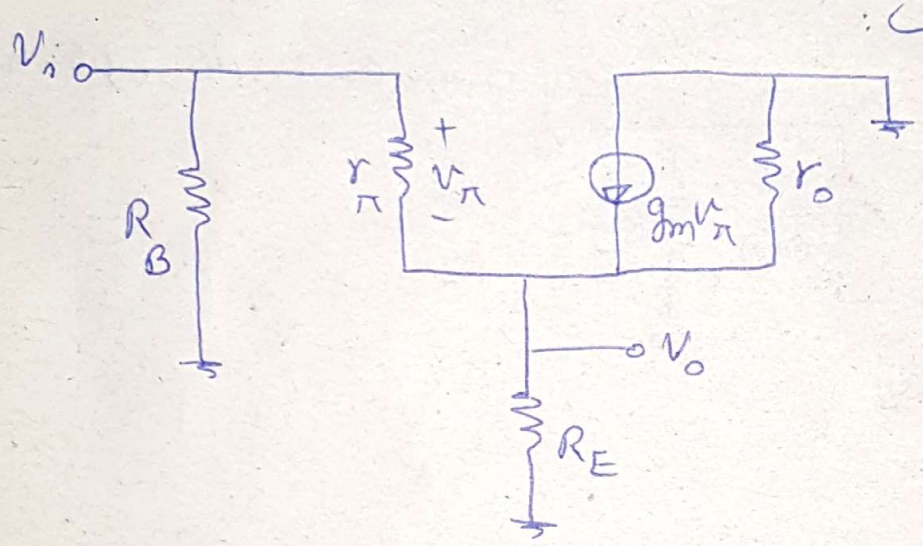
2) با کلیل DC مقادیر داریم:

$$I_C = 2mA \Rightarrow r_\pi = 1.25k\Omega$$

$$g_m = 80\,mS$$

$$r_o = 75k\Omega$$

مدار معادل AC به صورت زیر است:



$$A_V = \frac{R_E}{R_E + \frac{r_\pi}{\beta}} = \boxed{0.994}$$

$$R_i' = r_\pi + \beta R_E = 223k\Omega \Rightarrow R_i = R_i' \| R_B = \boxed{133k\Omega}$$

$$R_o = R_E \| \frac{r_\pi}{\beta} \| r_o \simeq R_E \| \frac{r_\pi}{\beta} = \boxed{12.4\,\Omega}$$

با قرار دادن R_S مقادیر داریم:

$$R_{oB} = r_o \| \left(r_e + \frac{R_S'}{\beta}\right), \quad R_S' = R_S \| R_B$$

$$R_o = R_{oB} \| R_E \simeq \boxed{32\,\Omega}$$

3) با تحلیل DC بدست می آوریم:

$I_C = 1.06\,mA$

$g_m = 42.4\,mS$

$r_e = \frac{r_\pi}{\beta} = 23.6\,\Omega$

$r_o = 189\,k\Omega$

در تحلیل AC خواهیم داشت:

$R_i \simeq r_e = 23.6\,\Omega$

$$v_e = \frac{R_i}{R_i + R_S} v_S = 0.7 v_S$$

$$\frac{v_o}{v_e} = g_m R'_C \;,\; R'_C = R_C \| R_L$$

$$\Rightarrow \frac{v_o}{v_S} = 0.7 \cdot \frac{v_o}{v_e} = \frac{v_e}{v_S} \cdot \frac{v_o}{v_e} = 0.7 \times 283 = 198$$

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4) تحلیل DC:

$I_C = 0.78\,mA \;,\; r_e = \frac{r_\pi}{\beta} = 32\,\Omega$

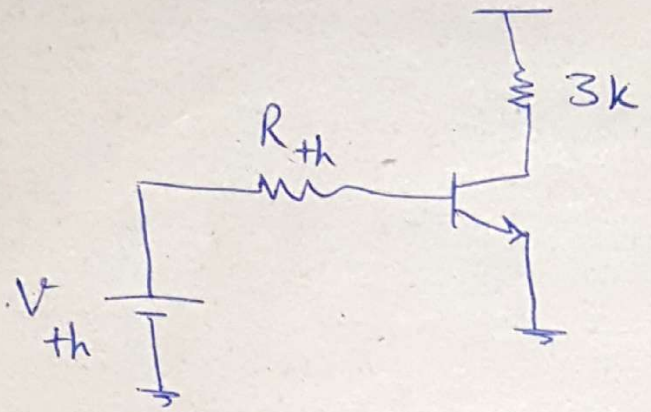
تحلیل AC:

$R_i = 6.8k \| r_e \simeq 32\,\Omega$

$R_o = 4.7\,k\Omega$

$$A_v = \frac{R_C}{r_e} = 147 \;,\; \frac{v_i}{6.8k} = \frac{r_e i_e}{6.8k} = 5 \times 10^{-3} i_e$$

$$\Rightarrow A_i = \frac{\alpha i_e}{i_e} \simeq 1$$



$$R_{th} = 34 \| 16 = 10.88k\Omega$$

$$V_{th} = \frac{16}{16+34} \times 2.5 = 0.8v$$

$$I_C = \beta\left(\frac{0.8 - V_{BE}}{10.88k}\right), \quad V_{BE} = V_T \ln\frac{I_C}{I_S}$$

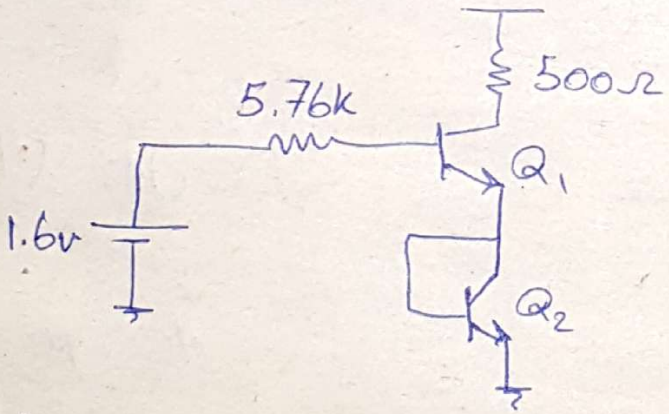
با فرض $V_{BE}=0.7v$ داریم:

$$I_C = 0.92mA, \quad V_{BE} = 0.734v$$

با روش تکرار بدست می آوریم:

$$I_C = 0.67mA, \quad V_{BE} = 0.726v$$

$$I_B = 6.7\mu A, \quad V_{CE} = 0.49v$$



$$I_{C_2} = \beta\left(\frac{1.6 - V_{BE_1} - V_{BE_2}}{5.76k}\right)$$

$$V_{BE} = V_{BE_1} = V_{BE_2} = V_T \ln\left(\frac{I_C}{I_S}\right)$$

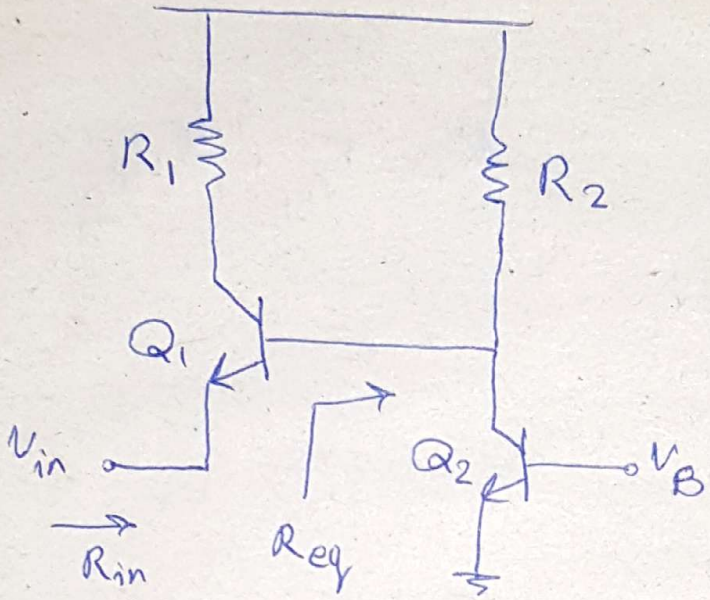
فرض:

$$V_{BE_1} = V_{BE_2} = 0.7v \Rightarrow I_C = 3.47mA \Rightarrow V_{BE} = 0.769v$$

با روش تکرار خواهیم داشت:

$$I_{C_1} = I_{C_2} = 1.74\ mA, \quad I_{B_1} = I_{B_2} = 17.4\ \mu A$$

$$V_{BE_1} = V_{BE_2} = 0.75v, \quad V_{CE_1} = 0.88v, \quad V_{CE_2} = 0.75v$$

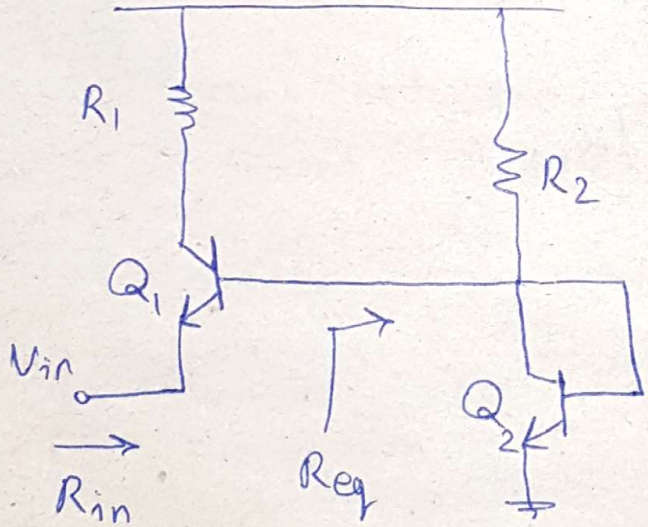


$$R_{eq} = R_2 \| \infty = R_2$$

$$R_{in} = \frac{1}{g_{m1}} \| r_{\pi 1} + \frac{R_2}{\beta_1 + 1}$$

$$\boxed{R_{in} = \frac{1}{g_{m_1}} + \frac{R_2}{\beta_1}}$$

با توجه به اینکه β معمولاً خیلی بزرگ است:

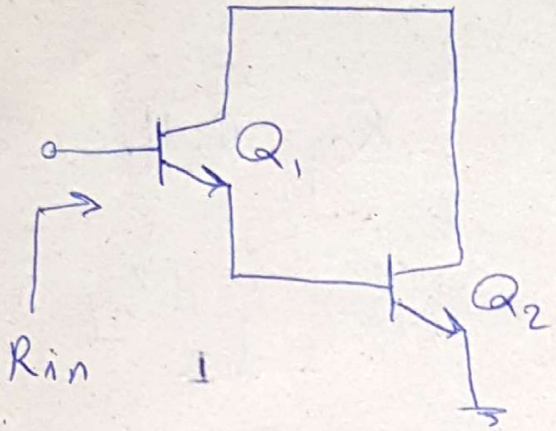


$$R_{eq} = R_2 \| \frac{1}{g_{m_2}} \| r_{\pi 2}$$

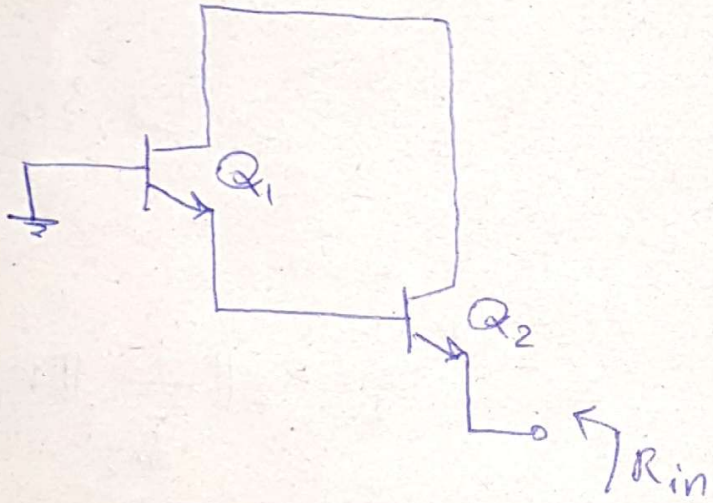
$$R_{in} = \frac{1}{g_{m_1}} \| r_{\pi_1} + \frac{R_{eq}}{\beta + 1}$$

با توجه به بزرگ بودن β داریم:

$$\boxed{R_{in} = \frac{1}{g_{m_1}} + \frac{R_{eq}}{\beta}}$$



$$R_{in} = r_{\pi_1} + \beta r_{\pi_2}$$



$$R_{in} = \frac{1}{g_{m_2}} + \frac{\frac{1}{g_{m1}}}{\beta}$$