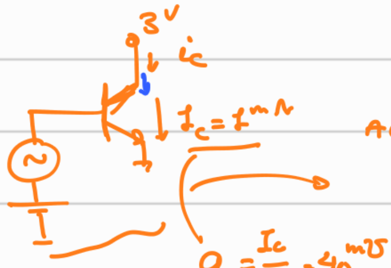
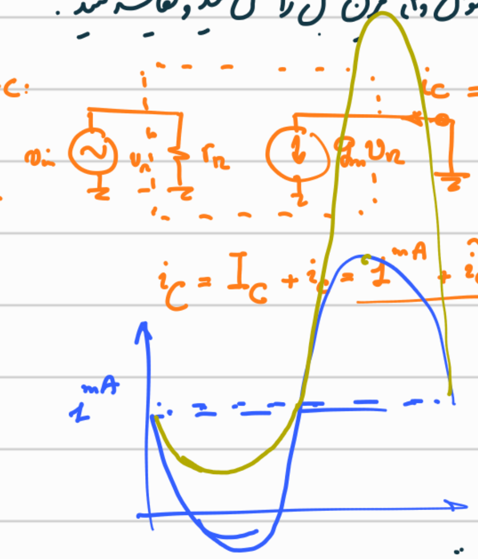
تمرین سری هفتم - سوال ستاره (*) دار اختیاری است . با اسپایس (SP) تایید شود.

۱- با مدل سیگنال کوچک هایبرید π ترانزیستور جوابهای سوال (۹) تمرین قبل را حل کنید و مقایسه کنید.



$g_m = \frac{I_c}{V_{th}} = 40^{m℧}$

AC:

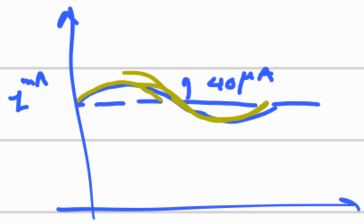


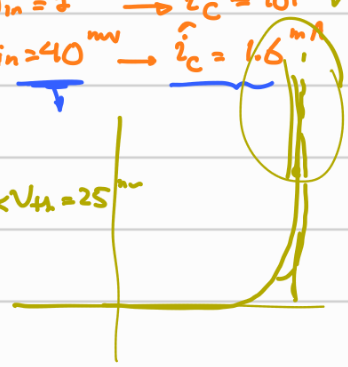
$i_c = g_m v_\pi$

$v_{in} = 1^{mV} \to \hat{i}_c = 40^{\mu A}$ ✓

$v_{in} = 40^{mV} \to \hat{i}_c = 1.6^{mA}$

$i_c = I_c + i_c = 1^{mA} + \hat{i}_c \sin\omega t$





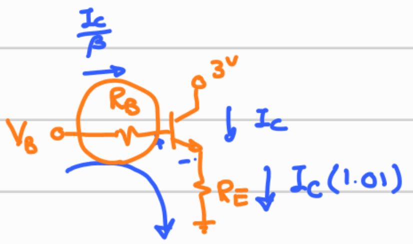
۲. در مدار شکل روبرو $I_s = 1^{fA} = 10^{-12\,mA}$, $\beta = 100$ است. (SP)

الف) $R_E = 0$ و $R_B = \{0, 1^k, 10^k, 100^{k\Omega}\}$ ، V_B را طوری پیدا کنید که $I_c = 1^{mA}$ باشد.

ب) $R_E = 0$, $R_B = 30^{k\Omega}$, $V_B = 0.9^V$ ، I_c را بیابید.

ج) با $R_E = 1^{k\Omega}$, $R_B = 40^{k\Omega}$ ، V_B را بیابید تا $I_c = 0.5^{mA}$ شود.

د) (*) اگر بجای I_s ترانزیستور فرض $V_{BE_{on}} = 0.7$ را اعمال می کردید چه تفاوتی می کرد!



$$V_B = \frac{I_c}{100} \times R_B + V_{BE} + I_c R_E$$

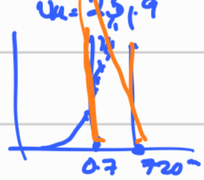
$R_B = 0$: $V_B = V_{th} \ln\left(\frac{I_c}{I_s}\right) = 60^m \times 12 = 720^{mV}$

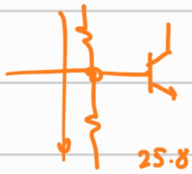
$R_B = 1^k$: $V_B = 0.01 + 0.72 = 0.73^{mV}$ → $i_c = 3^{mA}$

$R_B = 10^k$: $V_B = 0.1 + 0.72 = 0.82^{mV}$ → $= 1.2^{mA}$

$R_B = 100^k$: $V_B = 1 + 0.72 = 1.72^V$ → $= 1.02^{mA}$

$1^k = R_E$, $R_B = 0$





$$V_B = 0.9^V = \frac{30^k}{100} \times i_c + 25.8 \ln\left(\frac{i_c}{I_s}\right) \to i_c = \frac{0.9 - 0.7}{0.3} = 0.67^{mA}$$

$V_{BE_o} \approx 0.7$

$\to V_{BE_{on}} = V_{th} \ln\left(\frac{i_c}{I_s}\right) = 0.702$

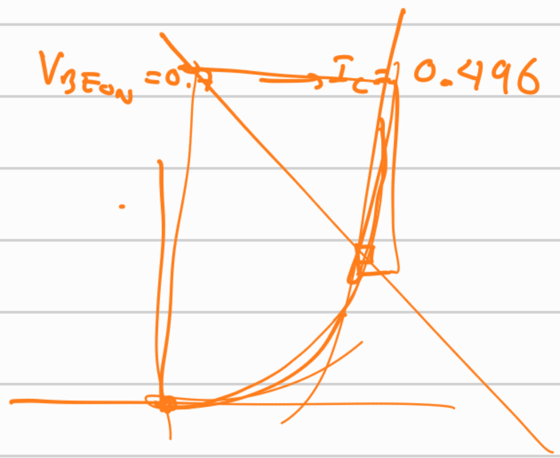
$i_c = 0.66^{mA}$

(د)

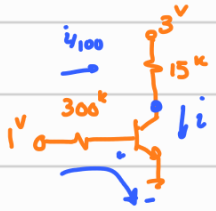
$$V_B = \underbrace{0.2}_{\frac{I_c R_B}{\beta}} + \underbrace{0.695}_{V_{BE_o}} + \underbrace{0.5}_{I_c R_E} = 1.395^V$$

$I_c = 0.5^{mA}$

$V_{BE_{on}} = 0.7 \to I_c = 0.496^{mA}$



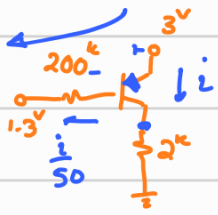
۴. اطلاعات ترانزیستور: npn: $I_S = 10^{-16}\,A$, $\beta = 100$ — pnp: $I_S = 5\,fA$, $\beta = 50$ — نقطه کار (I_C, V_{CE}) را بدست آورید (sp)



$1 = 3i + 0.7 \rightarrow i_c = 0.1\,mA \rightarrow V_{BE} = V_{th}\ln(\frac{i_c}{I_S}) = 0.713 \rightarrow i_c = 0.0956$

$V_{BE} = 0.712 \rightarrow i_C = 0.096$ ...

$V_{CE} = 1.56\,V$ ✓



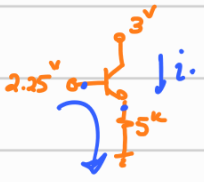
$1.7 = 3 - 1.3 = |V_{BE}| + \frac{200}{50} i_c$, $0.7 = V_{BE}$

$i_C = 0.25\,mA \rightarrow V_{BE} = V_{th}\ln(\frac{i_C}{I_S}) = 0.635$

$i_C = 0.266 \rightarrow V_{BE} = 0.637$

$i_C = 0.266$

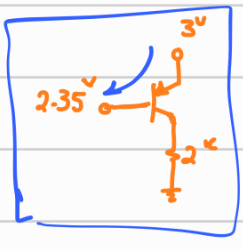
$V_{EC} = 3 - (2K \times 0.266) = 2.47$ ✓



$2.25 = V_{BE} + i_C 5K \rightarrow i_C = 0.31 \rightarrow V_{BE} = 0.742$

$i_C = 0.3$

$V_{CE} = 1.5\,V$

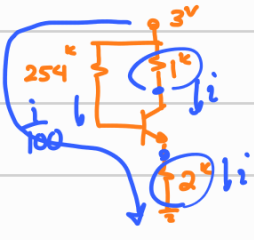


$3 - 2.35 = 0.65 = V_{th}\ln\frac{i_C}{I_S} \rightarrow i_C = I_S e^{\frac{0.65}{0.0258}} = 0.437\,mA$

$5 \times 10^{-12}\,mA$

$V_{EC} = 2.126\,V$

$V_{th} = 25\,mV \Rightarrow i_C = 0.97\,mA$



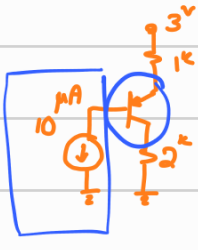
$3 - V_{BE} = i(2K + \frac{254K}{100})$

$= i(4.54)$

$i_C = 0.506 \rightarrow V_{BE} = 0.754$

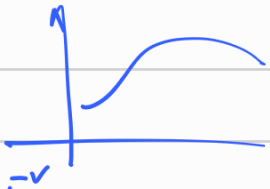
$i_C = 0.495$ V_{BE} ...

$V_{CE} = 3 - 3Ki = 1.52\,V$ ✓

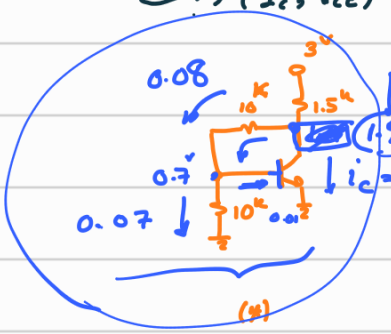


$i_C = 0.5\,mA$

$V_{EC} = 3 - (3 \times 0.5) = 1.5\,V$

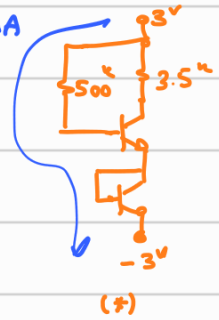


۴. فرض $V_{BE_{on}} = 0.7^V$ ، $\beta = 100$ نقطه کار ترانزیستور (I_c, V_{CE}) را بدست آورید.



1 mA

0.92

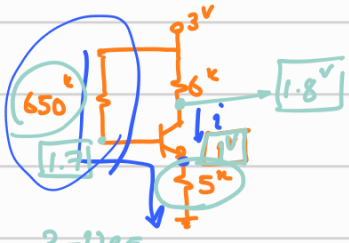


$\frac{6-1.4}{5} = i$

0.92

? $7 \gg 1$

۵. اگر $I_S = 10^{-15}A$ ، $\beta = 100$ باشد نتایج (۴) چه تغییری می‌کند؟ اگر $I_S = 5 \times 10^{-15}A$ شود (متناظر چه تغییرهایی است؟) چطور؟ (sp)



0.8^V

$I_S = 10^{-15} = 10^{-12}$ mA

$V_{BE} = 0.671$

$i = 0.202$ mA

$3 - V_{BE}$

$2.3 = i(5 + 6.5)$

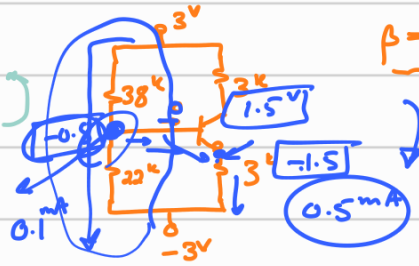
11.5

$i = 0.2$ mA

$I_S = 5 \times 10^{-15}$

$V_{BE} = 0.63$

$i = 0.206$



$\beta = \infty$

3V

$5^{\mu A} \ll 0.1^{mA}$

$-3^V + 0.1^{mA} \times 22^K = -0.8^V$

$3 - V_{BE}$

$\frac{80}{100}$

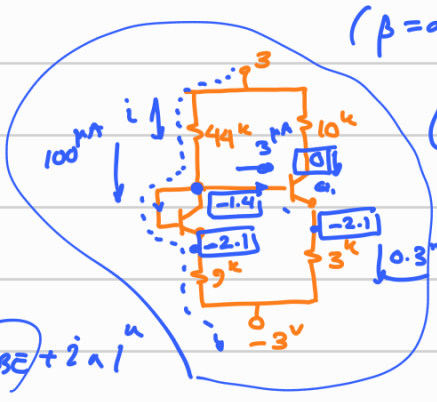
$2.3 = i(2.8 + 0.8 + 1)$

$i = 0.5$ mA

$3^V = i \times 2.8^K + \frac{i}{100} \times 80^K + V_{BE} + i \times 1^K$

$i(2.8 + 0.8 + 1)$

$(\beta = \infty)$



$6 - 0.7 = i(44 + 9)$

$i = 0.1$ mA

$V_{CE_1} = 2.1^V$