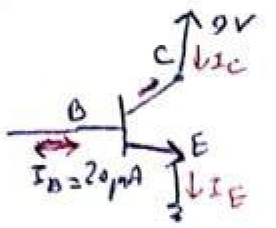
سری 13 - ص 1

⑫ $60 < \beta < 300$



$I_E = I_B + I_C$

$I_E = (\beta+1) I_B \Rightarrow 61 \times 20\,\mu A < I_E < (301) \times 20\mu A \rightarrow 1220\,\mu A < I_E < 6020\mu A$

$\boxed{1.22mA < I_E < 6.02mA}$

$I_C = \beta I_B \Rightarrow 60 \times 20\mu < I_C < 300 \times 20\mu$

$\boxed{1.2mA < I_C < 6mA}$

$\boxed{P_{max} = VI = 9^v \times 6mA = 72mw}$

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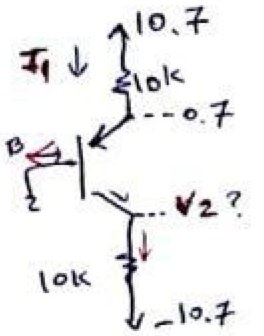
* با فرض روشن و active بودن حل می‌کنیم:
* دقت شود ترانزیستور pnp است.

28) ① $\beta \to \infty \rightarrow I_C = I_E$

$I_E = I_B + I_C \Rightarrow I_B = 0$

الف



$I_1 = \frac{10.7 - 0.7}{10k} = 1mA = I_E = I_1$

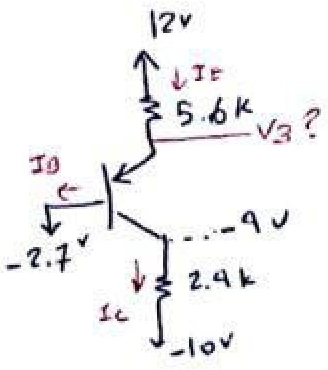
$I_E = I_C = 1mA$

$V_2 = -10.7 + 10k \times 1mA = -0.7v = V_2$

reverse ← $V_{CB} = -0.7$

forward ← $V_{EB} = 0.7$ → در حالت active ✓

ب



$V_B = -2.7v$
$V_C = -4v$
$V_{CB} = -1.3$

* دقت شود ترانزیستور pnp است
* فرض active و on

$I_C = \frac{-4-(-10)}{2.4k} = \frac{6}{2.4k} = 2.5mA$

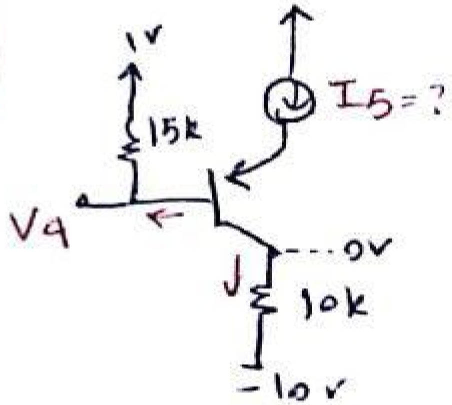
$\beta \to \infty \rightarrow I_B = 0 \Rightarrow I_C = I_E$

$\Rightarrow I_E = 2.5mA$

$\Rightarrow V_3 = \boxed{12 - 5.6k \times 2.5m = -2^v = V_3 = V_E}$

$V_{EB} = -2 + 2.7 = 0.7$
$V_{CB} = -1.3$
→ فرض درست است ✓

ت



*ترانزیستور , pnpاست

$\beta \to \infty \to I_B = 0$

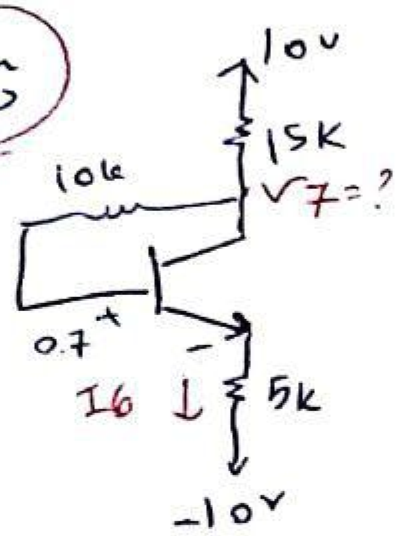
$V_B = V_4 = 1v$

$V_{CB} = 0 - 1 = -1v$

$I_C = \frac{0-(-10)}{10k} = 1mA$

$I_E = I_C = \boxed{1mA = I_5}$

ث



*ترانزیستور , npn است

$\beta \to \infty \to I_B = 0$

$\Rightarrow V_B = V_C = V_7 = V_E + 0.7$

$I_C = I_E$

$I_C = \frac{10 - V_7}{15k} = \frac{10 - V_B}{15k}$

$I_E = I_6 = \frac{(V_B - 0.7) = V_E - (-10)}{5k} = \frac{V_E + 10}{5k}$

$\Rightarrow$

$\Rightarrow \frac{10 - V_B}{15k} = \frac{V_B + 9.3}{5k} \Rightarrow V_B = V_7 = -4.475$

$I_6 = 0.965 \, mA$

$V_{BE} = 0$

$V_{BE} = -0.7$

$\rightarrow$ on, active

ادامه 28

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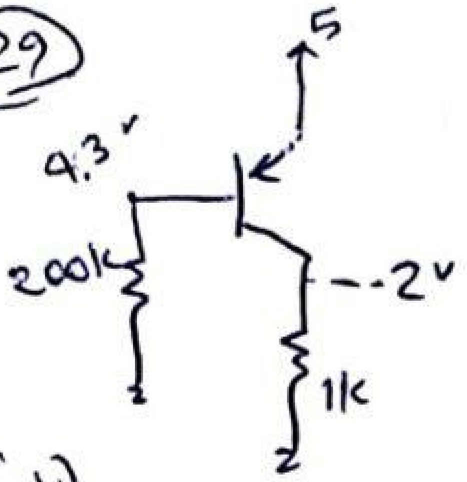


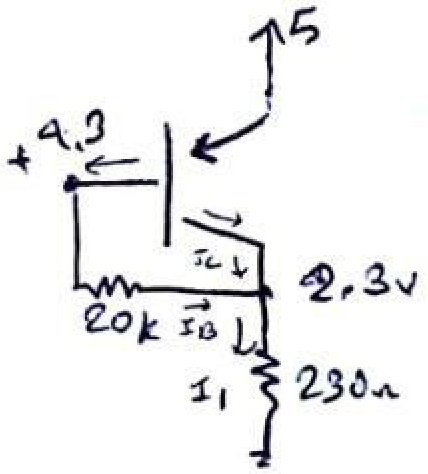
$I_C = \frac{2}{1k} = 2mA$

$I_B = \frac{4.3}{200k} = 2.15\,\mu A$

$I_C = \beta I_B$

$\Rightarrow \beta = \frac{2m}{2.15\mu} =$ ~~[illegible]~~ 930

(الف)



$I_C =$ ~~[illegible]~~?.

$I_C + I_B = I_1$

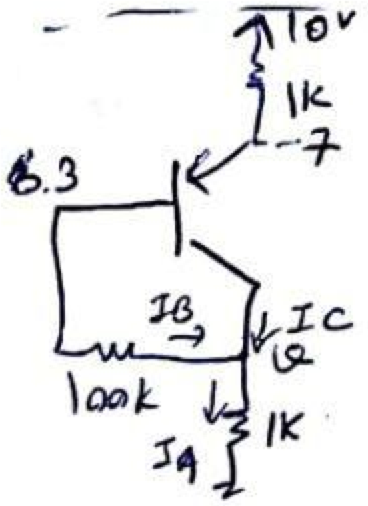
$I_B = \frac{+4.3 - 2.3}{20k} = 0.1mA$

$I_1 = \frac{2.3}{230\Omega} = 10mA$

$I_C = 9.9mA$

$\beta = \frac{I_C}{I_B} = \frac{9.9mA}{0.1mA} = 99$

(ب)



$I_E = \frac{10-7}{1k} = 3mA$

$I_C + I_B = I_1$ | $I_1 = (\beta+1) I_B$

$I_C = \beta I_B$

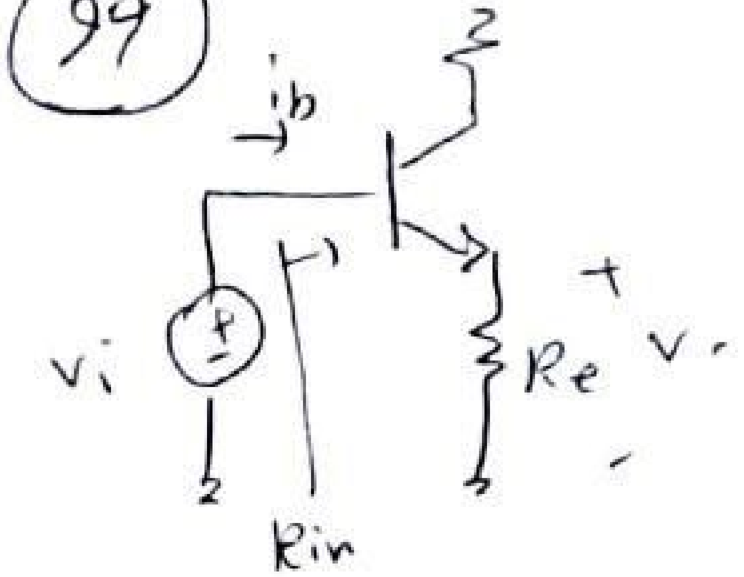
$I_E = (\beta+1) I_B$

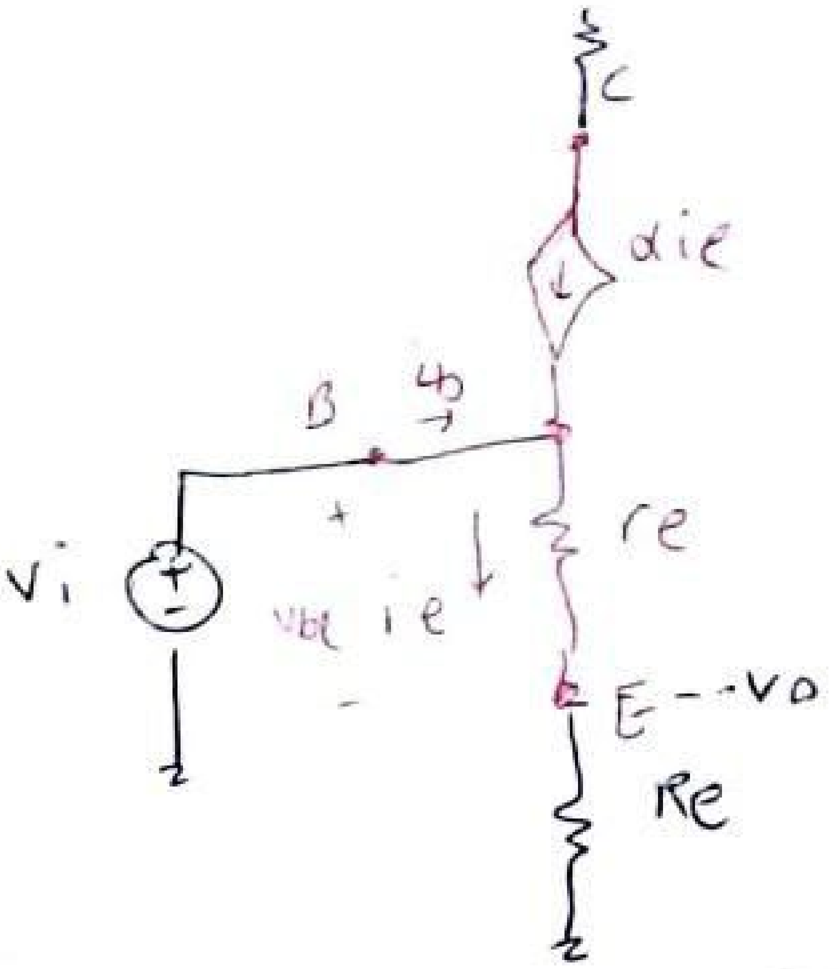
$\Rightarrow I_1 = I_E = 3mA$

$Q = I_1 \times 1k = 3v \rightarrow I_B = \frac{6.3-3}{100k} = 3.3\times10^{-5} = 33\mu A$

$\frac{I_E}{I_B} - 1 = \beta \Rightarrow \beta = \frac{3mA}{33\mu A} - 1 = 89.9$

(99)





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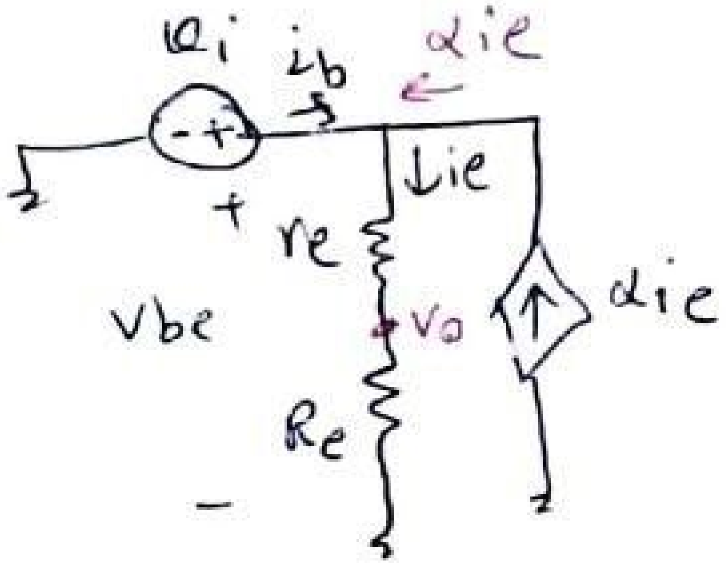

تست اصلی

$$R_{in}=\frac{v_i}{i_b}=(\beta+1)(r_e+R_e)$$

$$\frac{v_o}{v_i}=\frac{R_e}{R_e+r_e}$$

$$\checkmark\ \text{Ⓘ}\begin{cases} i_b+\alpha i_e=i_e \\ i_b=(1-\alpha)i_e \end{cases}$$

① $$R_{in}=\frac{v_{be}}{i_b}=\frac{(R_e+r_e)i_e}{i_b}\overset{\text{Ⓘ}}{=}\frac{(R_e+r_e)(i_e)}{(1-\alpha)i_e}=\frac{1}{1-\alpha}(R_e+r_e) \quad \Rightarrow R_{in}=(\beta+1)(r_e+R_e$$

$$\alpha=\frac{\beta}{\beta+1}$$

② $\frac{v_o}{v_i}=?$ تقسیم ولتاژ
ولتاژ در ۲ مقاومت
سری
$$\rightarrow v_i\times\frac{R_e}{R_e+r_e}=v_o \Rightarrow \boxed{\frac{v_o}{v_i}=\frac{R_e}{R_e+r_e}}$$

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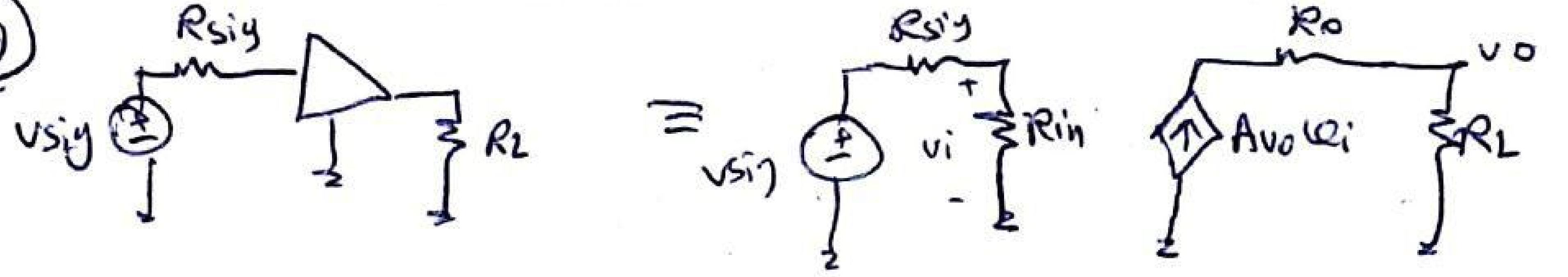


الف) $v_{sig} \times \frac{R_{in}}{R_{in}+R_{sig}} = v_i$

$v_i = \frac{90}{100} v_{sig}$

$R_{sig} = 100k$

$\Rightarrow \frac{R_{in}}{R_{in}+100k} = \frac{9}{10} \Rightarrow \boxed{R_{in} = 900k}$

ب) if $R_L = 2k \to v_o$

$\downarrow \qquad \downarrow$

$\frac{R_L}{2} = 1k \to \frac{90}{100} v_o$

$$\begin{cases} v_o = \frac{R_{in}}{R_{in}+R_{sig}} A_v \cdot v_{sig} \\ G_v = 10 \end{cases}$$

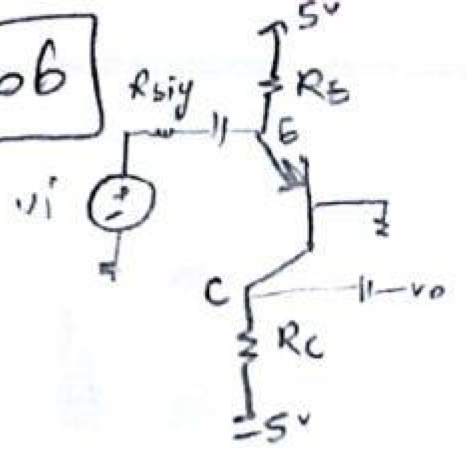
$$\to v_o = \frac{R_L}{R_L+R_o} \cdot v_i \cdot A_{vo} \Rightarrow \frac{\frac{1k}{1k+R_o} \cdot v_i \cdot A_{vo}}{\frac{2k}{2k+R_o} \cdot v_i \cdot A_{vo}} = \frac{\frac{90}{100} v_o}{v_o}$$

$$\boxed{\Rightarrow R_o = 250\,\Omega}$$

ج) $G_v = \frac{R_{in}}{R_{in}+R_{sig}} \cdot A_v = 10 \Rightarrow \boxed{A_v = 10 \times \left(\frac{10}{9}\right) = \frac{100}{9} = 11.1}$

$$A_v = \frac{R_L}{R_L+R_o} \cdot A_{vo} \Rightarrow A_{vo} = 11.1 \times \frac{2k+250\Omega}{2k} = 12.48$$

$\boxed{106}$



$g_m = \frac{1}{50}$

$R_{in} = 50\,\Omega = R_E \| r_e = r_e$

$\boxed{r_e = 50 = \frac{V_T}{I_E} = \frac{25m}{I_E} \Rightarrow I_E = 0.5\,mA}$

$V_E = 0.7$

$I_E = \frac{5 - V_E}{R_E} \Rightarrow \boxed{R_E = 8.6k\,\Omega}$

$V_{EC} = 10 - (R_E + R_C)\,0.5mA$

$$\left\{\begin{array}{l} A = g_m R_C \\ V_o = A \cdot v_i = A \cdot v_{be} \\ V_{be} < 10mv \end{array}\right| \Rightarrow V_o = A \times 10^{mv} = \frac{1}{50} \times R_C \times 10^{mv}$$

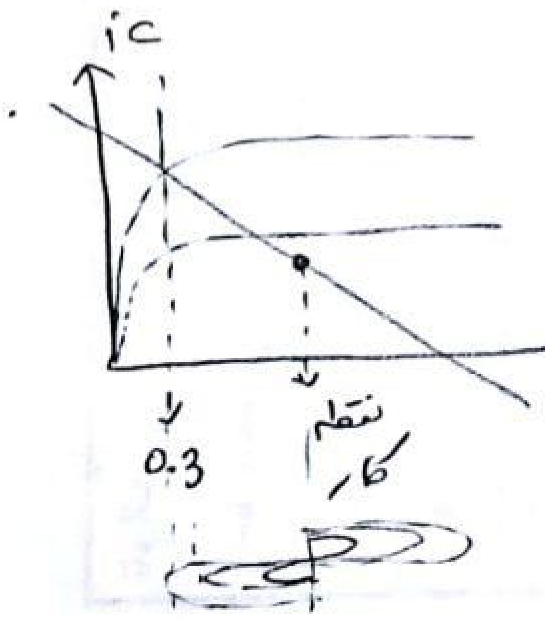
$V_{EC} - V_{omax} > 0.3$

$*\ 10 - (8.6k + R_C)0.5mA - \frac{1}{50} R_C \times 10^{m} > 0.3$

$\Rightarrow R_C < \boxed{\frac{5.4}{0.7m} = 7.7k\Omega}$

ماکزیمم بهره → $g_m R_c = \frac{1}{50} \times 7.7k = 154$

ماکزیمم خروجی → $V_o = A \cdot 10mv = 1.54\,v$



RC بزرگی بهره و در نتیجه مقدار
دامنه خروجی بیشتر است
از طرفی باید نقطه کار را طوری
انتخاب شود که با توجه به نوسانات
از مرز بحرانی $V_{EC}=0.3$ عبور نکنیم
بین مقدار VEC نقطه کار و ماکسیمم
حداکثر دامنه خروجی نباید از 0.3 کمتر
شود { معادله *

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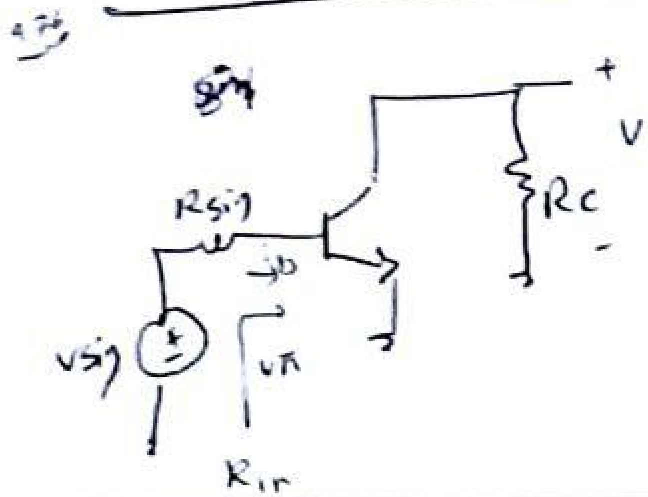

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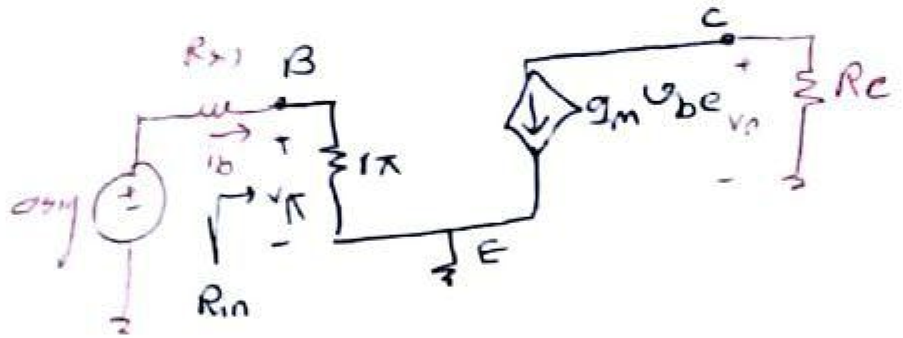

$v_\pi = v_{be}$

① $R_{in} = \frac{v_\pi}{i_b} = r_\pi$

② $\frac{v_\pi}{v_{sig}} \Rightarrow v_{sig} \times \frac{r_\pi}{r_\pi + R_{sig}} = v_\pi \Rightarrow \frac{v_\pi}{v_{sig}} = \frac{r_\pi}{r_\pi + R_{sig}}$

③ $\frac{v_o}{v_\pi} = ?$ $\left.\begin{matrix} v_o = R_c \cdot g_m v_{be} \\ v_{be} = v_\pi \end{matrix}\right\} \Rightarrow \frac{v_o}{v_\pi} = -R_c g_m$

$A_{v_t} = \frac{v_o}{v_{sig}} = \frac{v_o}{v_\pi} \times \frac{v_\pi}{v_{sig}} = -R_c g_m \cdot \frac{r_\pi}{r_\pi + R_{sig}}$

$\left(\begin{matrix} A_{v_t} \\ \text{vol} \\ G_v \end{matrix}\right) = -\frac{(g_m r_\pi) R_c}{r_\pi + R_{sig}} = -\frac{\beta R_c}{r_\pi + R_{sig}}$

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