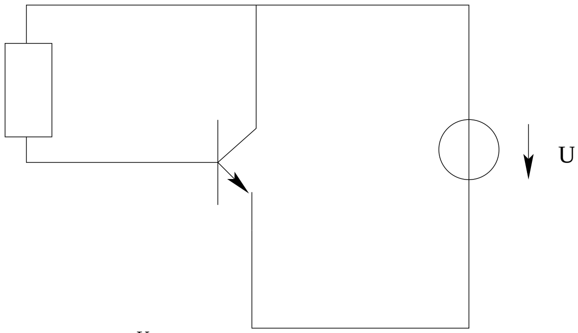
Aufgabe A)



$I_C = I_S e^{(\frac{U_{BE}}{U_T})}, \quad I_C = 10mA, \quad I_S = 10^{(-15)}A$

$$U_{BE} = ln\left(\frac{I_C}{I_S}\right) U_T = 778,2mV \approx 0,8V$$
$$U_R = \frac{I_C}{B_F} R = 0,5V$$
$$\Rightarrow U = U_{BE} + U_R \approx 1,3V$$

Bei Δ T von 100 C und 1,7$\frac{mV}{C} \approx 200mV$
$\Rightarrow U_{BE} = 600mV\,statt\,800mV \Rightarrow I_B\;steigt\;um\;\frac{7}{5} = 40\%, wie\;I_C$

Aufgabe B)

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$U_{BE} = U_3 - U_2$

$$\begin{pmatrix} G_G + g_b & 0 & -g_b \\ 0 & g_0 + G_L + g_{be} & -g_{be} \\ -g_b & -g_{be} & g_b + g_{be} \end{pmatrix} \begin{pmatrix} U_1 \\ U_2 \\ U_3 \end{pmatrix} = \begin{pmatrix} I_0 \\ U_{BE} g_m \\ 0 \end{pmatrix} = \begin{pmatrix} I_0 \\ U_3 g_m - U_2 g_m \\ 0 \end{pmatrix}$$

$$\begin{pmatrix} G_G + g_b & 0 & -g_b \\ 0 & g_0 + G_L + g_{be} + g_m & -g_{be} - g_m \\ -g_b & -g_{be} & g_b + g_{be} \end{pmatrix} \begin{pmatrix} U_1 \\ U_2 \\ U_3 \end{pmatrix} = \begin{pmatrix} I_0 \\ 0 \\ 0 \end{pmatrix}$$

$$U_1 = \frac{\begin{vmatrix} I_0 & 0 & -g_b \\ 0 & g_0 + G_L + g_{be} + g_m & -g_{be} - g_m \\ 0 & -g_{be} & g_b + g_{be} \end{vmatrix}}{det\ G}$$

$$= \frac{I_0(g_0 + G_L + g_{be} + g_m)(g_b + g_{be}) + I_0(-g_{be} - g_m)g_{be}}{det\ G}$$

analog U_2 und U_3

$$U_2 = \frac{I_0 g_b (g_{be} + g_m)}{det\ G}$$

$$U_3 = \frac{I_0 g_b (g_0 + G_L + g_{be} + g_m)}{det\ G}$$

$$\begin{aligned} V_U = \frac{U_2}{U_1} &= \frac{I_0 g_b (g_{be} + g_m)}{I_0(g_0 + G_L + g_{be} + g_m)(g_b + g_{be}) + I_0(-g_{be} - g_m)g_{be}} \\ &= \frac{(g_{be} + g_m)\frac{1}{r_b}}{g_0(g_b + g_{be}) + G_L(g_b + g_{be}) + \frac{1}{r_b}(g_{be} + g_m)} \\ &= \frac{(g_{be} + g_m)\frac{1}{r_b}}{\underbrace{(g_b + g_{be})(g_0 + G_L)}_{1} + \underbrace{\frac{1}{r_b}(g_{be} + g_m)}_{2}} \\ &\overset{1 \ll 2}{=} 1 \end{aligned}$$

$$V_I = \frac{I_2}{I_1}$$

$$I_1 = (U_1 - U_3)g_b = \frac{I_0 g_b g_{be}(g_0 + G_L)}{det\ G} \qquad I_2 = -U_2 G_L = -\frac{I_0 G_L g_b (g_{be} + g_m)}{det\ G}$$

$$V_I = \frac{-I_0 G_L g_b (g_{be} + g_m)}{I_0 g_b g_{be}(g_0 + G_L)} = \frac{-G_L(g_{be} + g_m)}{g_{be}(g_0 + G_L)}$$

$$G_L \gg g_0$$

$$V_I = \frac{-(g_{be} + g_m)}{g_{be}} = -1 - \beta \approx -\beta$$

$$
\begin{aligned}
R_{ein} = \frac{U_1}{I_1} &= \frac{I_0[(g_{be}+g_b)(g_0+G_L)+g_b(g_{be}+g_m)]}{I_0 g_b g_{be}(g_0+G_L)} \\
&= \frac{g_b(g_{be}+g_m+g_0+G_L}{g_b g_{be}(g_0+G_L)} + \frac{g_{be}(g_0+G_L)}{g_b g_{be}(g_0+G_L)} \\
&= \frac{g_{be}+g_m+g_0+G_L}{g_{be}(g_0+G_L)} + r_b \\
&\approx r_b + \beta(R_L + r_e)
\end{aligned}
$$

$$
\begin{aligned}
R_{aus} &= \frac{U_2}{I_2} \\
U_2 &\left(\frac{1}{r_b + R_G + \frac{1}{g_{be}}} + g_0 + g_m U_{BE}\right) = I_2 \\
U_2 &\left(\frac{1}{r_b + R_G + \frac{1}{g_{be}}} + g_0 + g_m \frac{\frac{1}{g_{be}}}{\frac{1}{g_{be}} + r_b + R_G}\right) = I_2 \\
U_2 &\left(g_0 + \frac{1 + \overbrace{\frac{g_m}{g_{be}}}^{\beta}}{r_b + R_G + \frac{1}{g_{be}}}\right) = I_2 \\
\Rightarrow R_{aus} &= \frac{1}{g_0 + \dfrac{1+\beta}{r_b + R_G + \dfrac{1}{g_{be}}}} = \frac{R_G + r_b}{\beta} + r_e
\end{aligned}
$$