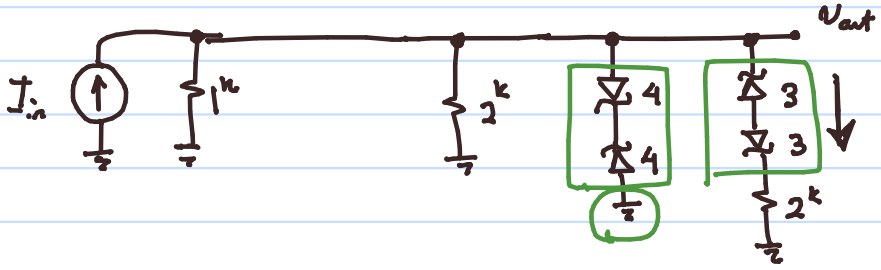
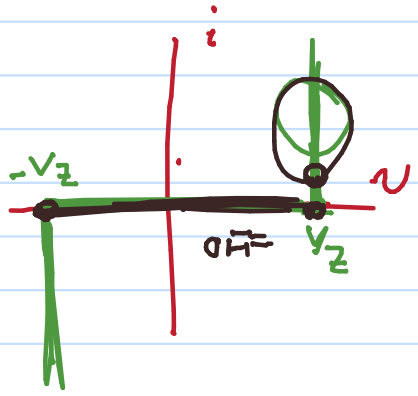
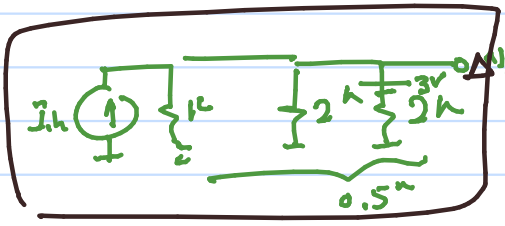




$-3 < v_{out} < 3$

$v_{out} = 1 \| 2 \times I_{in} = \frac{2}{3} k I_{in}$

$3 < |v_{out}| < 4$

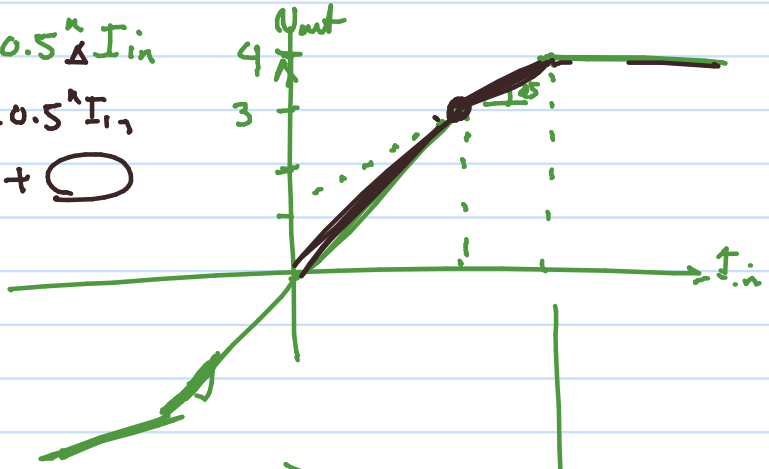


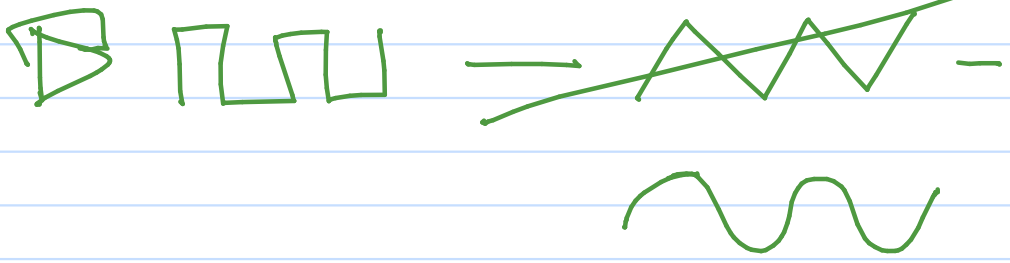
$v_{out} = 0.5 \Delta I_{in}$

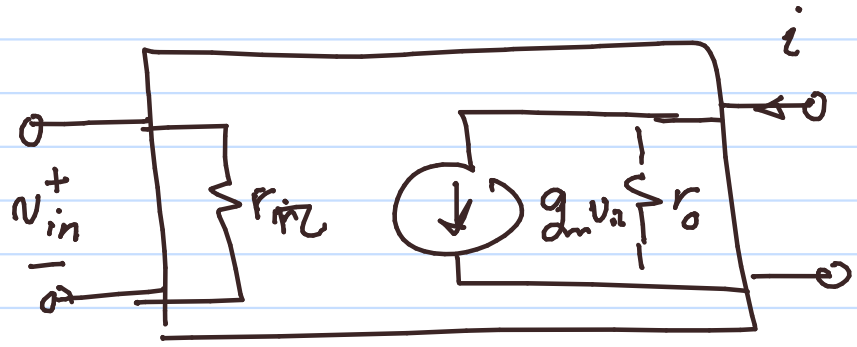
$v_{out} = 0.5 I_{in}$

+

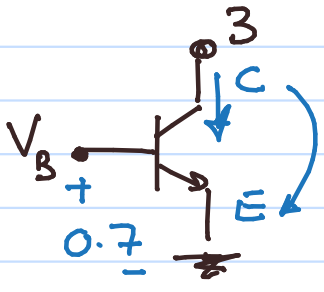
$|v_{out}| > 4$ $\quad v_{out} = 9^V$

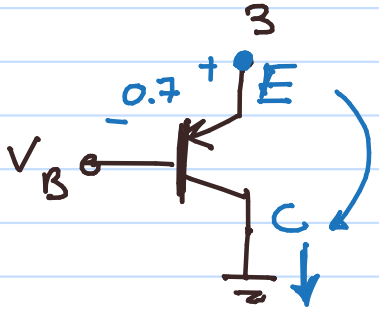






npn	pnp
V_{BE}	V_{EB}
V_{CE}	V_{EC}

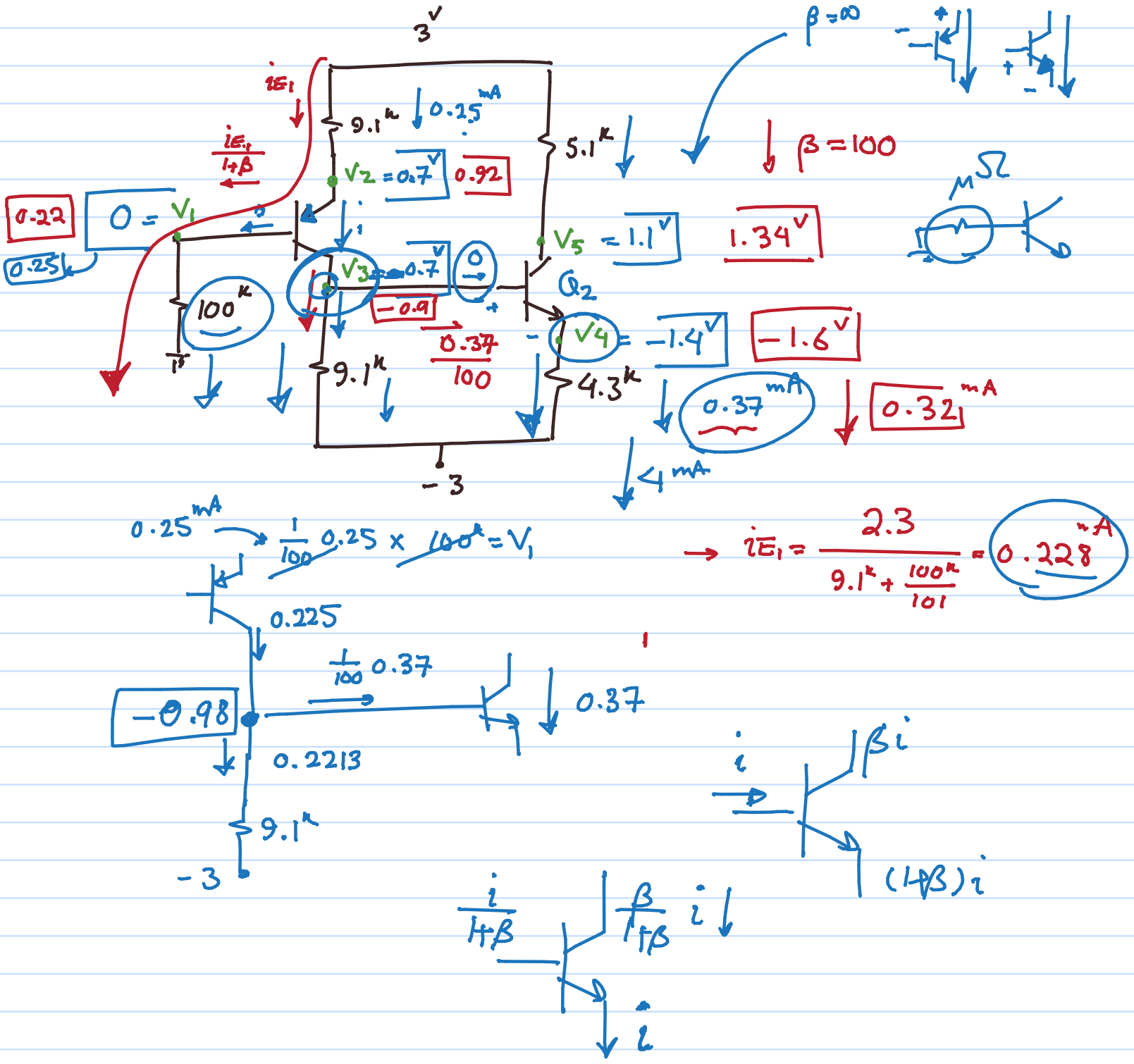




$$I_C = I_S\, e^{V_{BE}/V_T}\left(1+\frac{V_{CE}}{V_A}\right)$$

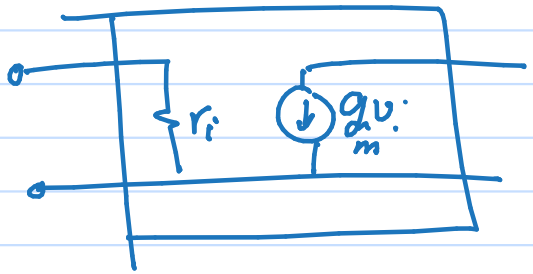
V_{EB} $\qquad$ V_{EC}

$I_C =$


3 V
i_{E_1}
$\frac{i_{E_1}}{1+\beta}$
9.1 K
0.25 mA
5.1 K
$V_2 = 0.7$ V
0.92
0.22
0.25 K
$0 = V_1$
$V_3 = 0.7$ V
0
$V_5 = 1.1$ V
1.34 V
100 K
Q_2
−0.9
$\frac{0.37}{100}$
$V_4 = -1.4$ V
−1.6 V
9.1 K
4.3 K
0.37 mA
0.32 mA
4 mA
−3
$\beta = \infty$
$\beta = 100$
mΩ
$0.25^{mA} \rightarrow \frac{1}{100} 0.25 \times 100^{K} = V_1$
$\rightarrow i_{E_1} = \frac{2.3}{9.1^{K} + \frac{100^{K}}{101}} = 0.228^{mA}$
0.225
$\frac{1}{100}$ 0.37
0.37
−0.98
0.2213
9.1 K
−3
i
βi
(1+β) i
$\frac{i}{1+\beta}$
$\frac{\beta}{1+\beta} i$
i

$$I_C = \alpha I_B^2$$

$$I_C = I_S e^{V_{BE}/V_T}$$



$$g_m \triangleq \frac{\Delta I_{out}}{\Delta V_{in}} = \frac{\partial I_C}{\partial V_{BE}} = \frac{I_C}{V_T}$$

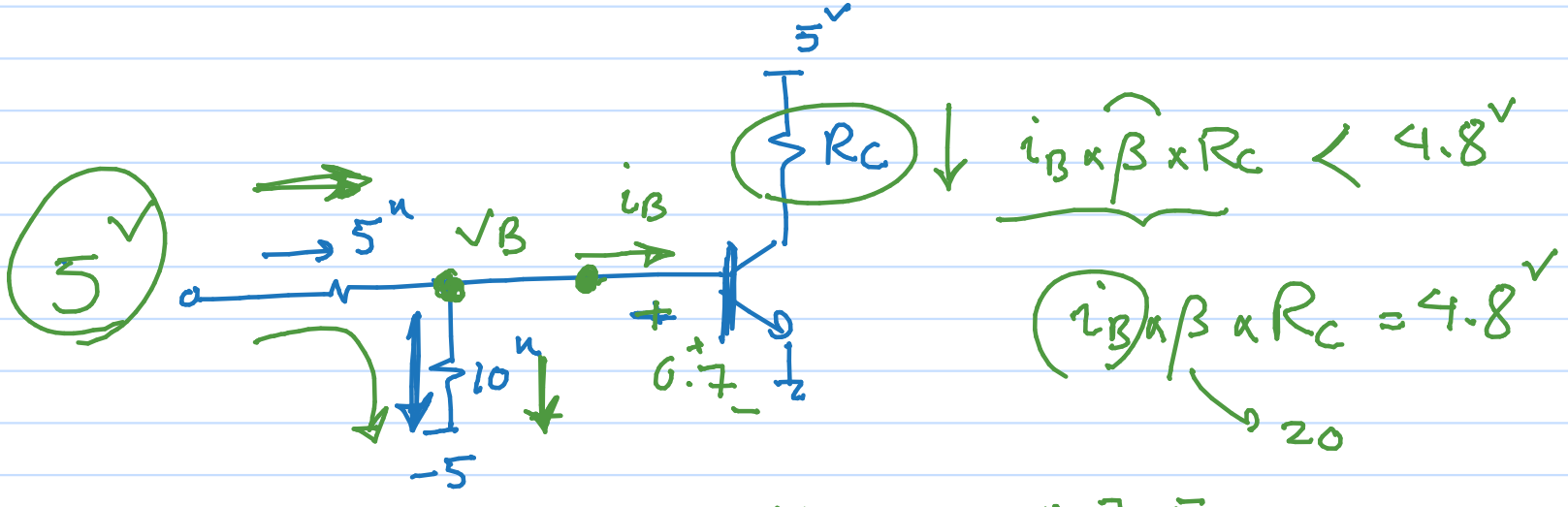
$$r_i \triangleq \frac{\Delta V_{in}}{\Delta I_{in}} = \frac{\partial V_{BE}}{\partial I_B} = \left(\frac{\partial I_B}{\partial V_{BE}}\right)^{-1}$$

$$= \left(\frac{\partial I_C}{\partial V_{BE}} \frac{\partial I_B}{\partial I_C}\right)^{-1}$$

$$= = \frac{2\alpha}{I_C}\sqrt{\frac{I_C}{\alpha}}\, V_T$$

$I_C = \alpha I_B^2$

$\frac{\partial I_C}{\partial I_B} = 2\alpha I_B =$

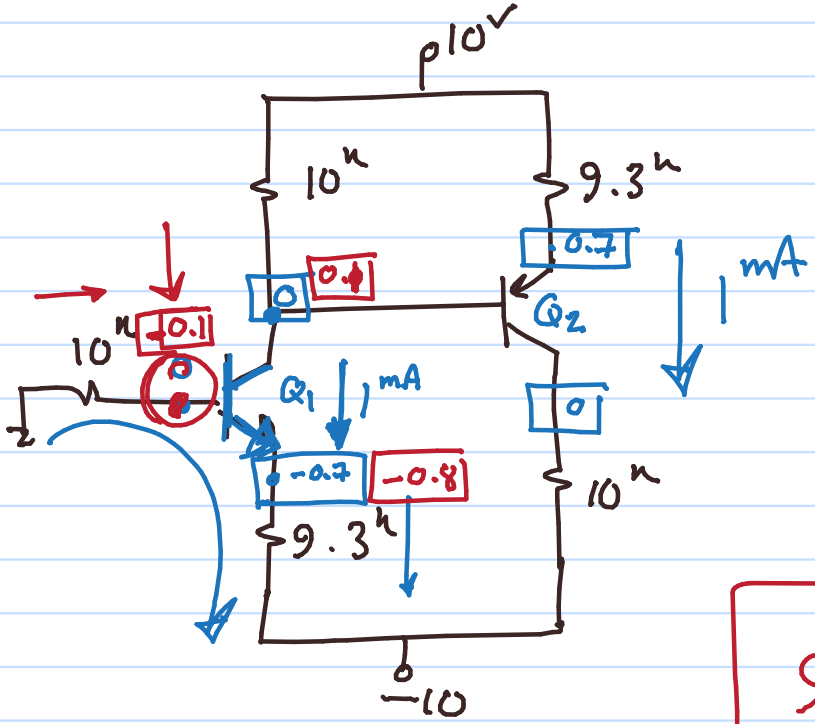


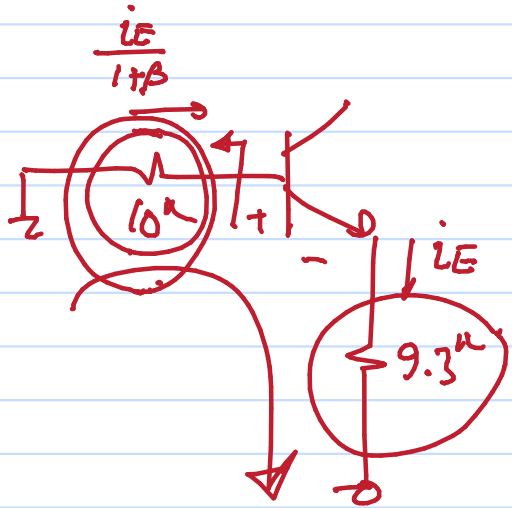
$i_B \times \beta \times R_C < 4.8^V$

$i_B \times \beta \times R_C = 4.8^V$

20

$$i_B = \frac{5 - 0.7}{5^k} = \frac{0.7 + 5}{10^k} =$$





$$9.3^{V} = i_E \left(9.3^{k} + \frac{10^{k}}{1+\beta} \right)$$

$$9.3^{k} \gg \frac{10^{k}}{1+\beta}$$