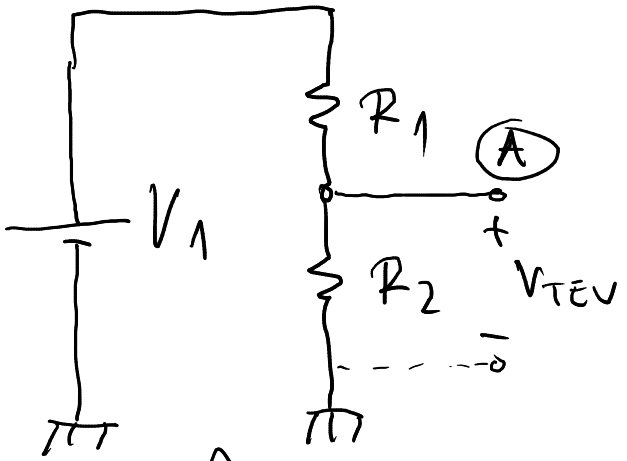
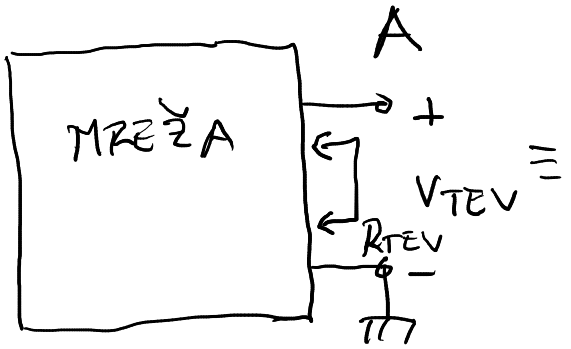
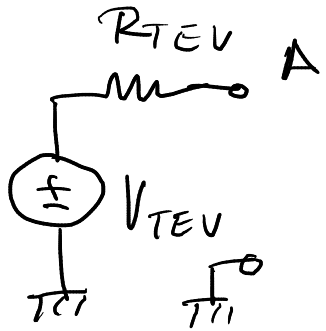
TEVENINOVA TEOREMA







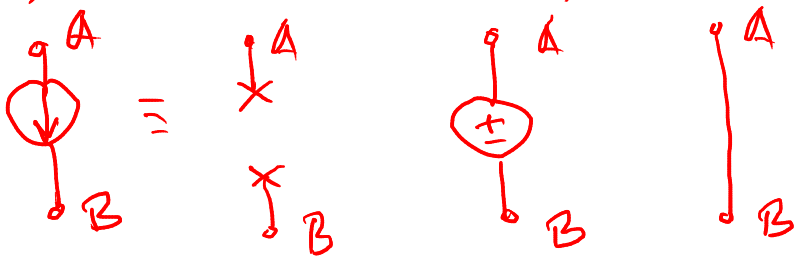
V_{TEV} - NAPON PRAZNOG HODA "PREKID"

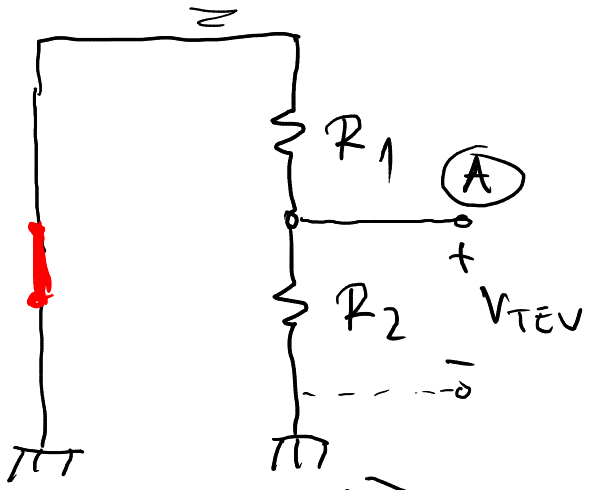
R_{TEV} - EKVIVALENTNA OTPORNOST

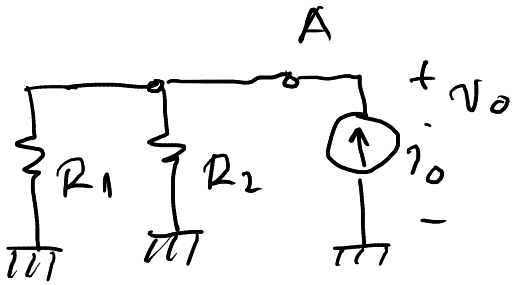
R_{ek} R_{ek}

$$V_{TEV} = \frac{R_2}{R_2+R_1} \cdot V_1 \,, \quad R_{TEV} = R_1 \| R_2$$

KADA TRAŽIMO EKVIVALENTNU OTPORNOST SVE GENERATORE MENJAMO NJIHOVIM UNUTRAŠNJIM OTPORNOSTIMA:



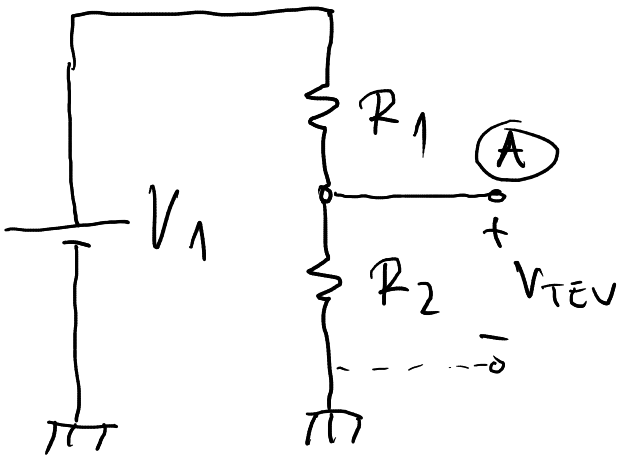


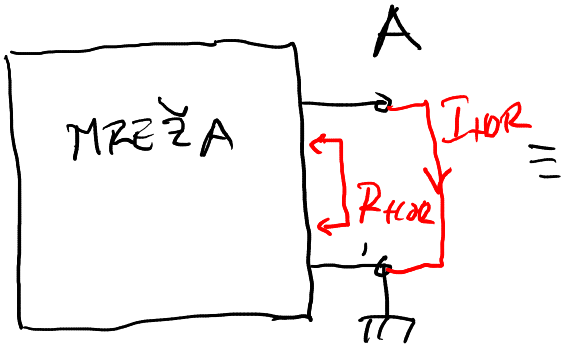


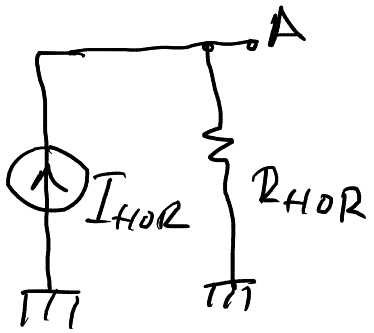
$$R_{ek} \triangleq \frac{V_0}{i_0} \quad ; \quad i_0 = \frac{V_0}{R_1 \| R_2}$$

$$R_{ek} = R_1 \| R_2 = R_{TEV}$$

HORTOHOVA TEOREMA



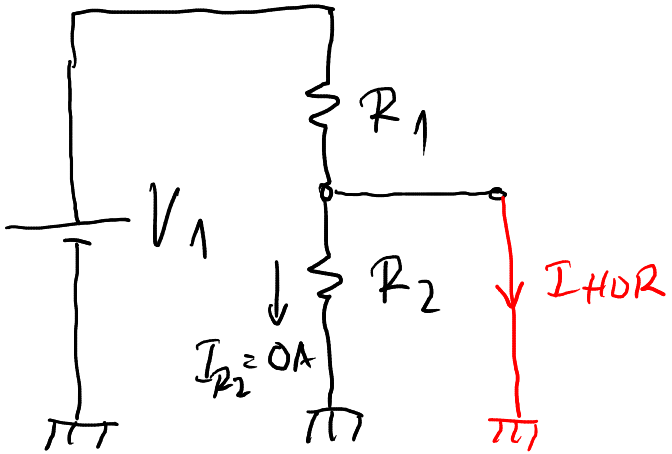




I_{HOR} = STRUJA KRATKOG SPOJA

$R_{HOR} \equiv R_{TEV}$

$$I_{HOR} = \frac{V_1}{R_1}$$

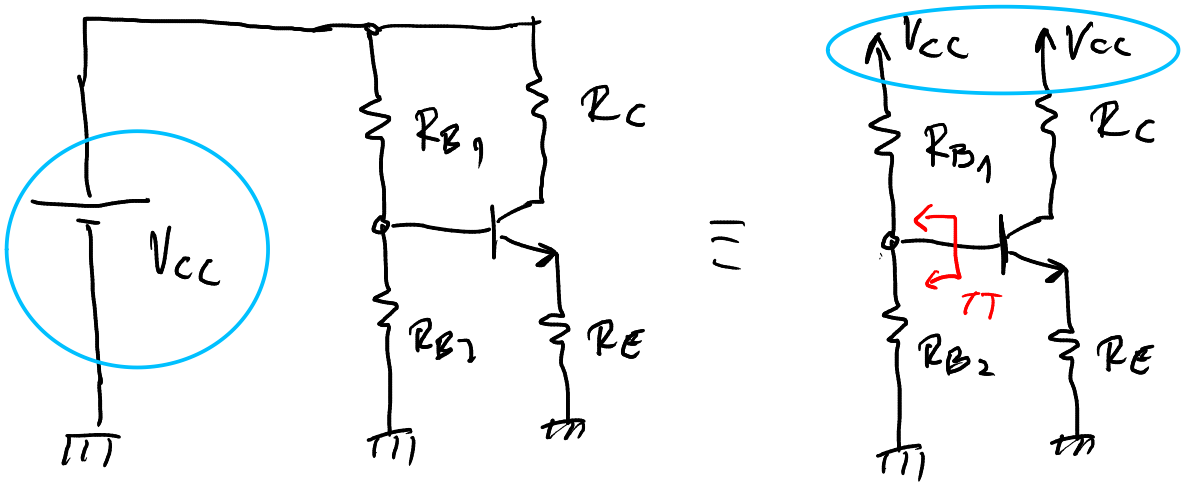


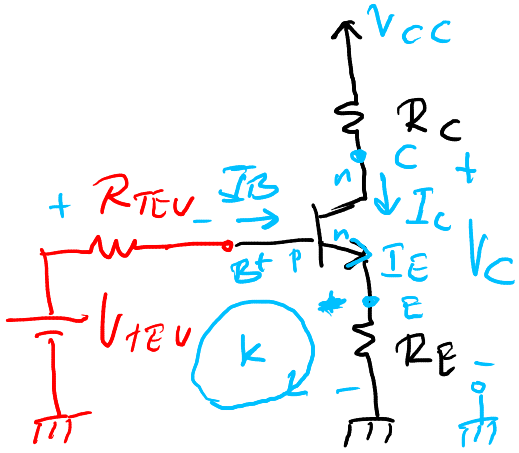
* KONVERZIJA iz HOR. u TEV. GENERATOR JE PUTEM OMOVOG ZAKONA:

$$I_{HOR} \triangleq \frac{V_{TEV}}{R_{TEV}} \quad ; \quad V_{TEV} \triangleq I_{HOR} \cdot R_{HOR}$$

$$V_{TEV} = I_{HOR} \cdot R_{HOR} = \frac{V_1}{R_1} \cdot \frac{R_1 \cdot R_2}{R_1 + R_2} = V_1 \frac{R_2}{R_1 + R_2}$$

$$I_{HOR} = \frac{V_1}{R_1}$$





$$V_{TEV} = \frac{R_{B2}}{R_{B2}+R_{B1}} \cdot V_{CC}$$

$$R_{TEV} = R_{B1} \| R_{B2}$$

U AKTIVNOM REŽIMU VAŽI:

$I_C = \beta I_B$

$I_E = (1+\beta) I_B$

$V_{BE} = V_{BE0} \approx (0{,}6 \text{ V} / 0{,}7 \text{ V})$

U LIJEVU VAŽI (1 KZ):

$I_E = I_C + I_B$

(k): $V_{TEV} = I_B \cdot R_{TEV} + V_{BE} + I_E \cdot R_E$

$V_{TEV} = I_B \cdot R_{TEV} + V_{BE} + (1+\beta) I_B R_E$

$$I_B = \frac{V_{TEV} - V_{BE}}{R_{TEV} + (1+\beta) R_E}$$

$\rightarrow I_C = \beta I_B$

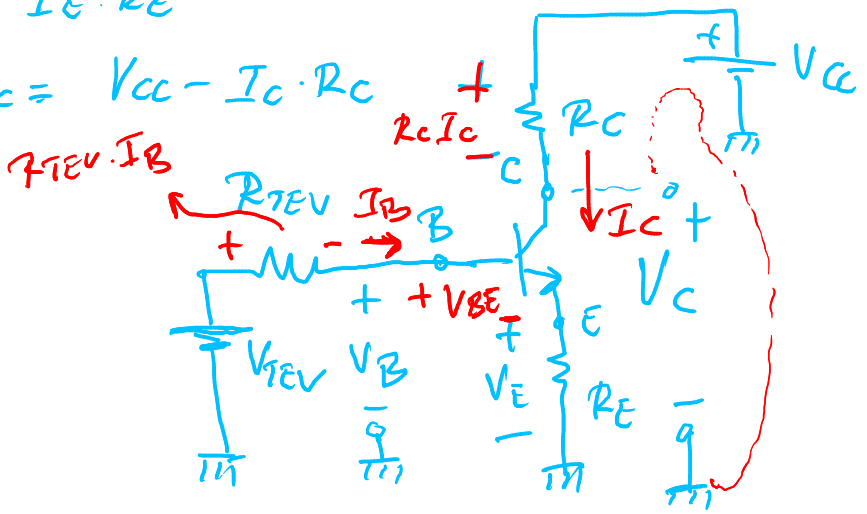
$\rightarrow I_E = (1+\beta) I_B$

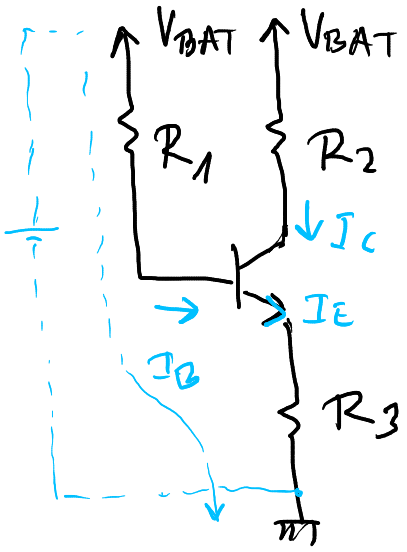
$\rightarrow V_E = I_E \cdot R_E$

$\rightarrow V_C = V_{CC} - I_C \cdot R_C$

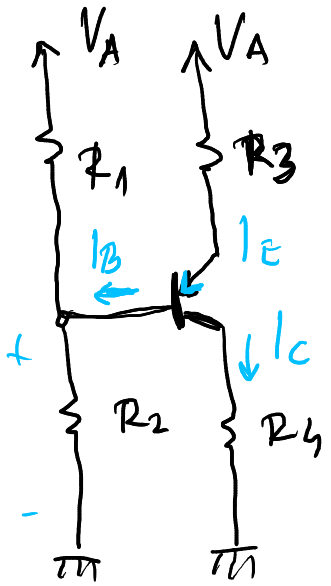
$V_B = V_{BE} + R_E \cdot I_E$

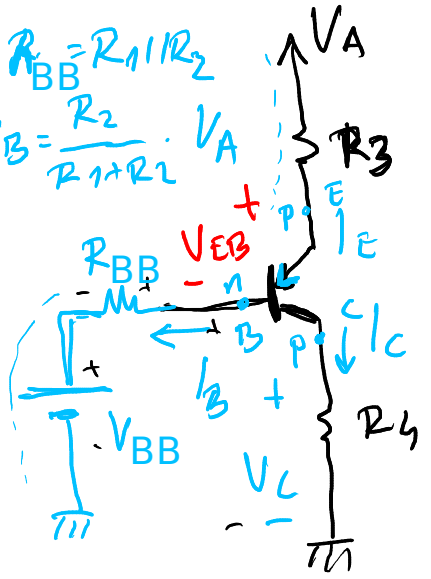
$= V_{TEV} - I_B R_{TEV}$



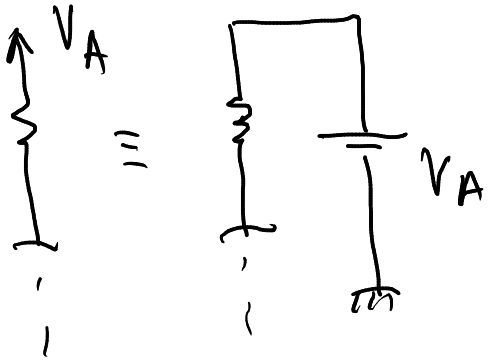


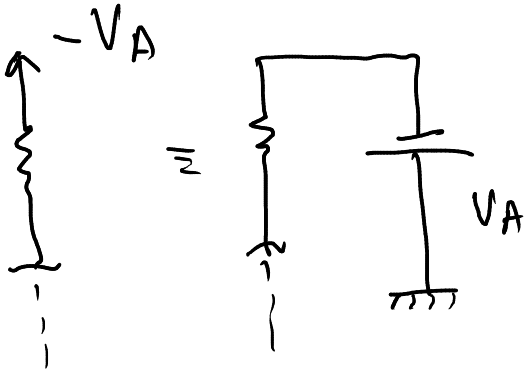
$$V_{BAT} = R_1 I_B + V_{BE} + (1+\beta) I_B R_3 \Rightarrow I_B = \frac{V_{BAT} - V_{BE}}{R_1 + (1+\beta) R_3}$$





* KOD PNP:
$V_{BE} < 0\ V$
ALI JE
$V_{EB} > 0\ V$!





$$V_B = -I_B R - V_{EB} - I_E R_3 + V_A$$

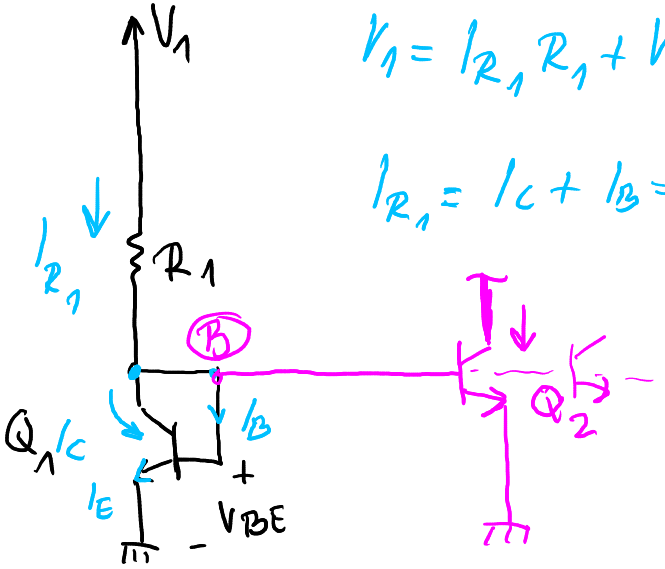
($(1+\beta) I_B$ ↑)

$$\boxed{I_B = \frac{V_A - V_{EB} - V_{BB}}{R_{BB} + (1+\beta) R_3}}$$

$$V_C = I_C R_4 \quad , \quad V_B = I_B R_{BB} + V_{BB} \, ,$$

$$V_E = V_{EB} + V_B = -I_E R_3 + V_A$$

STRUJNA OGLEDALA:



$$V_1 = I_{R_1} R_1 + V_{BE} = (1+\beta) I_B R_1 + V_{BE} \Rightarrow \quad I_B = \frac{V_1 - V_{BE}}{(1+\beta) R_1}$$

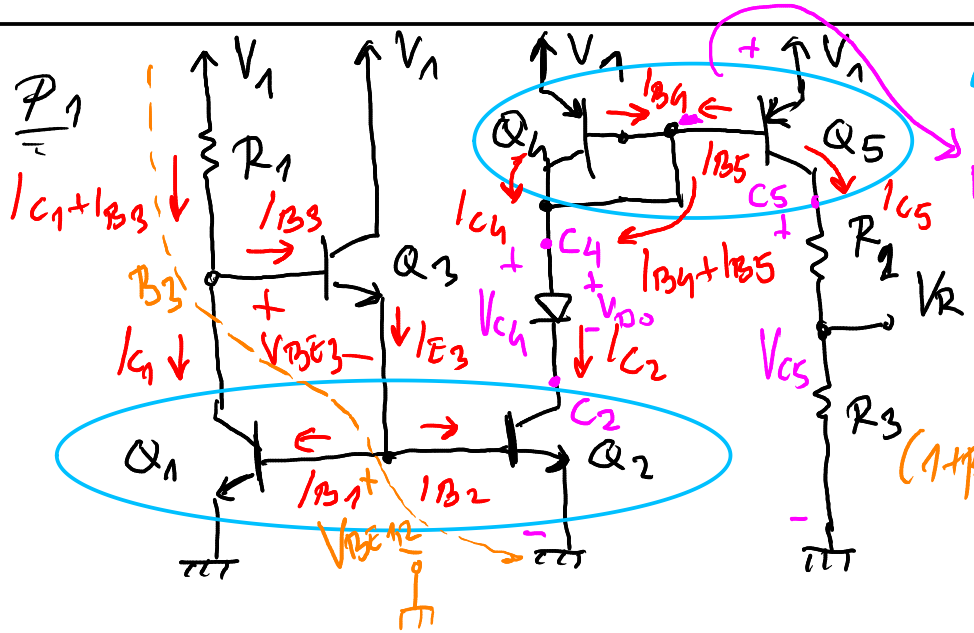
$$I_{R_1} = I_C + I_B = I_E = (1+\beta) I_B$$

AKO JE $Q_1 \equiv Q_2$ $(\beta_1 = \beta_2,\ V_{BE_1} = V_{BE_2}) \Rightarrow$

$$I_{C_1} = I_{C_2},\quad I_{B_1} = I_{B_2},\quad I_{E_1} = I_{E_2}$$

PROBLEM NASTAJE AKO IMA POSTA REPLIKA TRANZISTORA "Q_2":

(B) $$I_{R_1} = I_{C_1} + I_{B_1} + \sum_{i=2}^{N} I_{B_i}$$



UPARENI TRANZISTORI (MEĐUSOBNI): ISTO β.

$$V_{EB_4} = V_{EB_5},\quad V_{BE_1} = V_{BE_2},\quad V_D = V_{DO}\ (0.6, 0.7)\,V$$

$$I_{Q_4} = I_{Q_5},\quad I_{Q_1} = I_{Q_2}$$

$$V_1 = (I_{C_1} + I_{B_3}) R_1 + V_{BE_3} + V_{BE_{1,2}}$$

$$(1+\beta_3) I_{B_3} = I_{E_3} = I_{B_1} + I_{B_2} = 2 I_{B_{1,2}} \quad \text{tj.} \quad I_{C_1} = \beta_1 \cdot I_{B_1}$$

$$| V_{BE_1} = V_{BE_2},\ \beta_1 = \beta_2$$

$$V_1 = \left(\beta_1 I_{B_1} + \frac{2 I_{B_1}}{1+\beta_3}\right) \cdot R_1 + V_{BE_3} + V_{BE_1} \Rightarrow \boxed{I_{B_{1,2}} = \frac{V_1 - (V_{BE_3} + V_{BE_1})}{R_1 \cdot \left(\beta_1 + \frac{2}{1+\beta_3}\right)}}$$

$$I_{B_3} = \frac{I_{E_3}}{1+\beta_3} = \frac{2 I_{B_{1,2}}}{1+\beta_3}$$

$$\boxed{I_{C_2} = \beta_2 I_{B_2}}, \quad I_{B_2} = I_{B_1}$$

(C4) $I_{C_4} + I_{B_4} + I_{B_5} = I_{C_2} \Rightarrow \beta_4 I_{B_4} + 2 I_{B_4} = I_{C_2} \Rightarrow \boxed{I_{B_{4,5}} = \frac{I_{C_2}}{2+\beta_4}}$

$V_{EB_4} = V_{EB_5}$, $\beta_4 = \beta_5 \Rightarrow I_{B_4} = I_{B_5}$

$$\boxed{I_{C_4} = \beta_4 I_{B_4} = I_{C_5}} \Rightarrow \boxed{V_R = I_{C_5} \cdot R_3}$$

$$\boxed{V_{C_4} = V_1 - V_{EB_{4,5}}}$$

$$\boxed{V_{C_2} = V_{C_4} - V_{DD}}$$

$$\boxed{V_{C_5} = I_{C_5} \cdot R_2 + V_R = \left(1 + \frac{R_2}{R_3}\right) V_R}$$

$$\boxed{V_{B_3} = V_{BE_3} + V_{BE_{1,2}} = V_1 - (I_{C_1} + I_{B_3}) \cdot R_1}$$