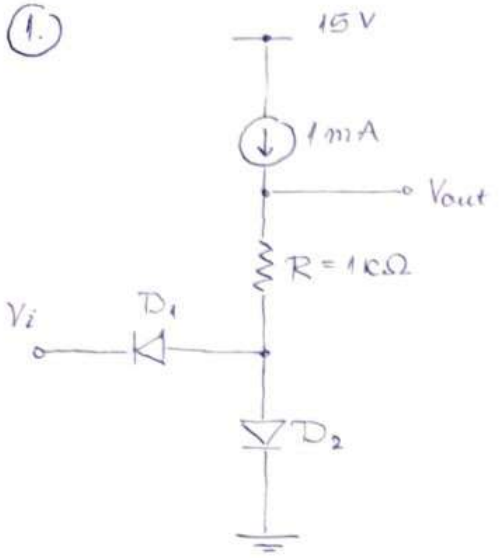
Основи електронике и дигитални техники

РЈЕШЕЊА

(1.)



1° $V_i < 0V$

Диода D_1 проводи, D_2 не проводи

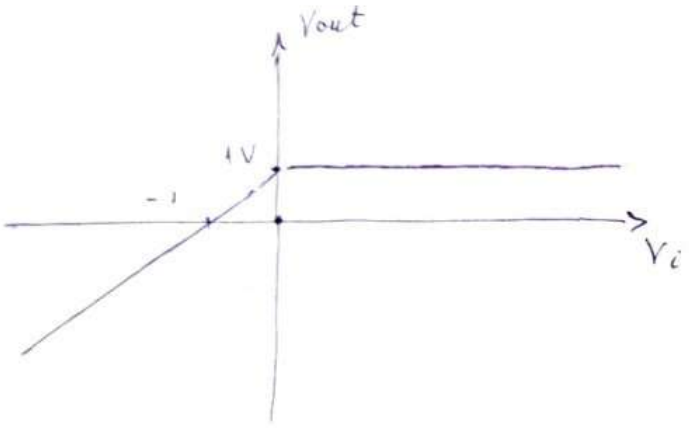
$V_{out} = V_{in} + 1V$

2° $V_i > 0V$

Диода D_2 проводи, D_1 не проводи

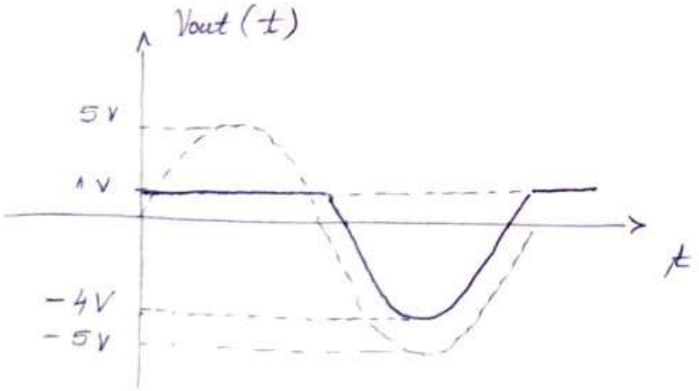
$V_{out} = 1mA \cdot R$

$V_{out} = 1V$

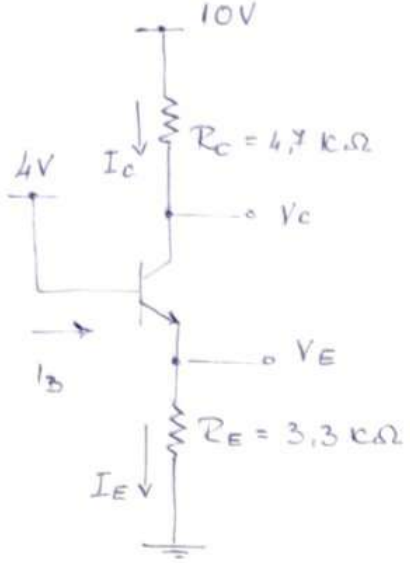


1° $V_{out} = 0 \Rightarrow V_{in} = -1V \quad (-1, 0)$

$V_{in} = 0 \Rightarrow V_{out} = 1V \quad (0, 1)$



(2.)



Претпоставимо активни режим.

$V_E = V_B - V_{BE}$

$V_E = 4V - 0,7V$

$V_E = 3,3V$

$I_E = \frac{V_E}{R_E} = 1\,mA$

$I_C = \alpha I_E, \quad \alpha = \frac{\beta}{1+\beta} \approx 0,99$

$I_C = 0,99\,mA$

$V_C = 10V - R_C I_C$

$V_C = 10V - 0,99\,mA \cdot 4,7\,k\Omega$

$V_C \approx 5,3V$

$V_{BC} = V_B - V_C$

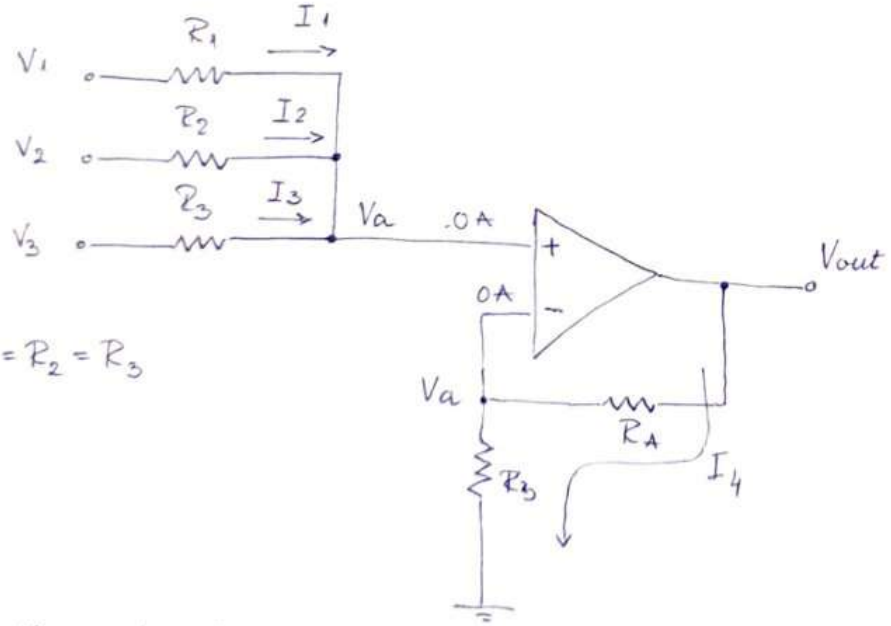
$V_{BC} = 4V - 5,3V$

$V_{BC} = -1,3V$

Претпоставка је добра!

$I_B = \frac{I_E}{1+\beta} = 0,01\,mA$

(3.)



$R_1 = R_2 = R_3$

$I_1 + I_2 + I_3 = 0$

$\frac{V_1 - Va}{R_1} + \frac{V_2 - Va}{R_2} + \frac{V_3 - Va}{R_3} = 0 \quad / \cdot R_1$

$I_4 = \frac{Va}{R_B}, \quad I_4 = \frac{Vout - Va}{R_A}$

$\frac{Va}{R_B} = \frac{Vout - Va}{R_A}$

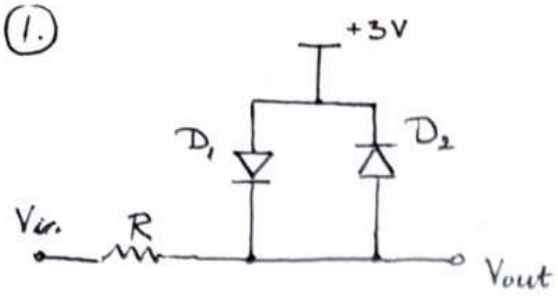
$Va = Vout \frac{R_B}{R_B + R_A}$

$V_1 - Va + V_2 - Va + V_3 - Va = 0$

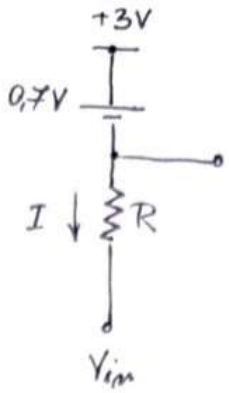
$V_1 + V_2 + V_3 = 3Va$

3. $Vout \frac{R_B}{R_B + R_A} = V_1 + V_2 + V_3 \Rightarrow Vout = \underbrace{\frac{1}{3}\left(1 + \frac{R_A}{R_B}\right)}_{A = \frac{1}{3}\left(1 + \frac{R_A}{R_B}\right)} (V_1 + V_2 + V_3)$

(1.)



1° D_1 *bogu*, D_2 *ne bogu*



$R = 500\,\Omega$

$I = 1\,mA$

$V_{in} + RI - V_{out} = 0$

$V_{out} = V_{in} + RI$

$V_{out} + 0{,}7V - 3V = 0$

$V_{out} = 2{,}3V$

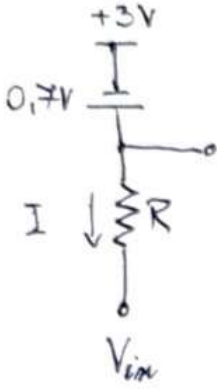
$V_{in} = V_{out} - RI$

$V_{in} = 2{,}3V - 500 \cdot 1mA$

$V_{in} = 2{,}3V - 0{,}5V$

$V_{in} = 1{,}8V$

2° D_1 *ne bogu*, D_2 *bogu*



$V_{out} - 0{,}7V - 3V = 0$

$V_{out} = 3{,}7V$

$V_{out} = V_{in} + RI$

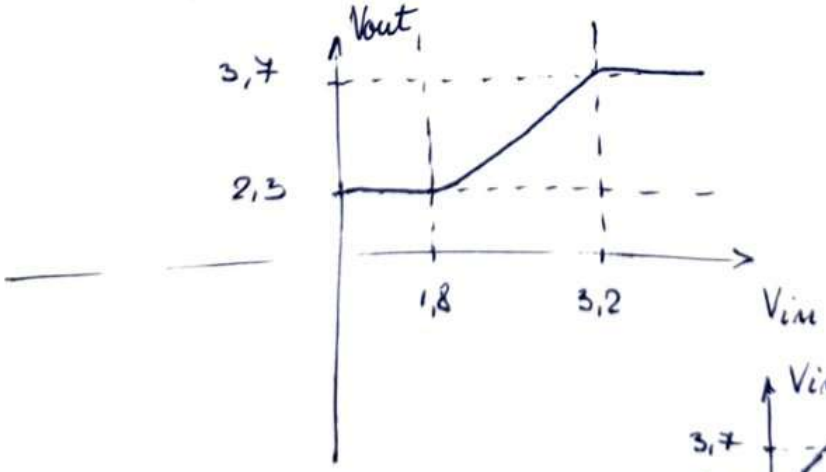
$V_{in} = V_{out} - RI$

$V_{in} = 3{,}7V - 500 \cdot 1mA$

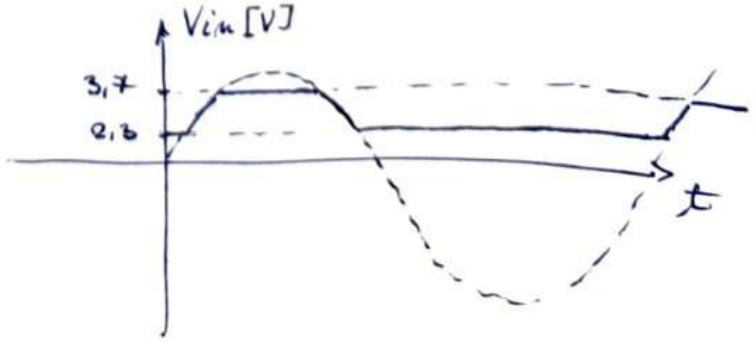
$V_{in} = 3{,}7V - 0{,}5V$

$V_{in} = 3{,}2V$

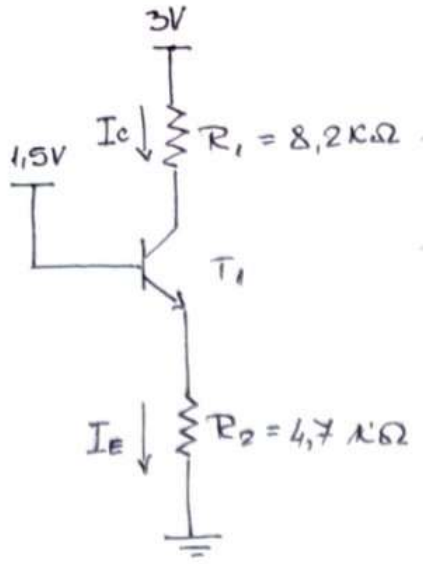
$$V_{out} = \begin{cases} 2{,}3V, & V_{in} \leq 1{,}8V \\ V_{in}, & 1{,}8 < V_{in} < 3{,}2V \\ 3{,}7V, & V_{in} \geq 3{,}2V \end{cases}$$



ПРЕНОСНА КАРАКТЕРИСТИКА



(2.)



Претпоставимо активни режим.

$V_{BE} = 0{,}7V$, $V_{BE} = V_B - V_E$

$V_E = V_B - V_{BE}$

$V_E = 1{,}5V - 0{,}7V$

$V_E = 0{,}8V$

$I_E = \frac{V_E - 0V}{R_2} = \frac{0{,}8V}{4{,}7k\Omega} = 0{,}17\,mA$

$I_C = \alpha I_E$, $\alpha = \frac{\beta}{1+\beta}$

$I_C = \frac{50}{51} I_E = 0{,}98 \cdot 0{,}17\,mA$

$I_C = 0{,}16\,mA$

$V_C = 3V - R_C I_C$

$V_C = 3V - 8{,}2k \cdot 0{,}16\,m$

$V_C = 3V - 1{,}4V$

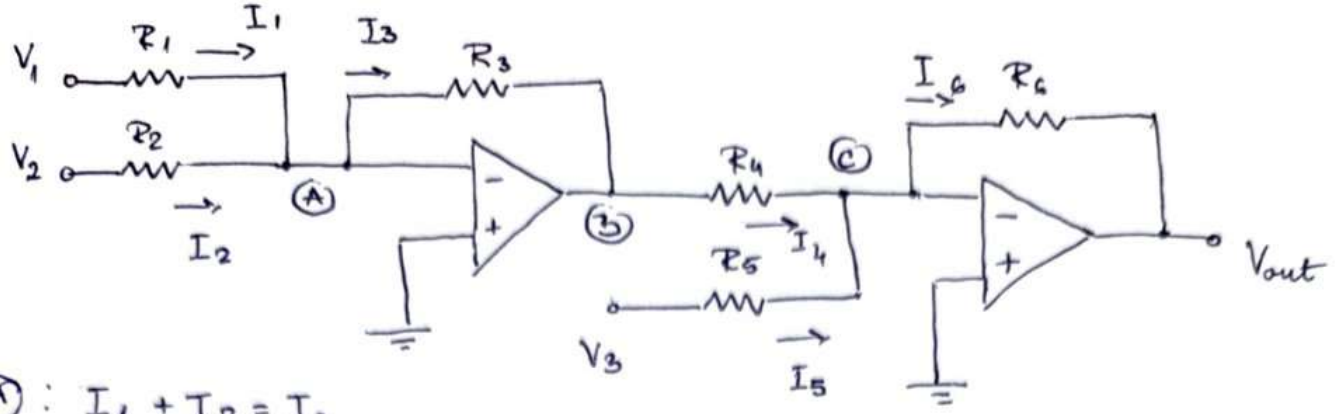
$V_C \approx 1{,}6V$

$$I_B = \frac{I_C}{\beta} = \frac{0{,}16\,mA}{50} = 0{,}0032\,mA$$

$$V_{BC} = V_B - V_C = 1{,}5V - 1{,}6V = -0{,}1V$$

Како је $V_{BC} < 0$, уз претпоставку да је $V_{BE} = 0{,}7V$, значи да смо у активном режиму и претпоставка је добра.

(3.)



(A): $I_1 + I_2 = I_3$

$$\frac{V_1 - V_a}{R_1} + \frac{V_2 - V_a}{R_2} = \frac{V_a - V_b}{R_3} \Big/ \cdot R_1R_2R_3$$

$$R_2R_3V_1 - \cancel{R_2R_3V_a} + R_1R_3V_2 - \cancel{R_1R_3V_a} = \cancel{R_1R_2V_a} - R_1R_2V_b$$

$V_a = 0V$ због виртуелне масе

$$R_2R_3V_1 + R_1R_3V_2 = -R_1R_2V_b \Big/ : R_1R_2$$

$$V_b = -\left(V_1\frac{R_3}{R_1} + V_2\frac{R_3}{R_2}\right) \quad (1)$$

(C): $I_4 + I_5 = I_6$

$$\frac{V_b - V_c}{R_4} + \frac{V_3 - V_c}{R_5} = \frac{V_c - V_{out}}{R_6},$$ V_c је такође виртуелна маса па је $V_c = 0V$

$$\frac{V_b}{R_4} + \frac{V_3}{R_5} = -\frac{V_{out}}{R_6} \Big/ \cdot R_6$$

$$V_{out} = -\left(\frac{R_6}{R_4}V_b + \frac{R_6}{R_5}V_3\right),$$ уврштавамо (1)

$$V_{out} = -\left(-V_1\frac{R_3R_6}{R_1R_4} - V_2\frac{R_3R_6}{R_2R_4} + \frac{R_6}{R_5}V_3\right)$$

$$\boxed{V_{out} = V_1\frac{R_3R_6}{R_1R_4} + V_2\frac{R_3R_6}{R_2R_4} - \frac{R_6}{R_5}V_3}$$

Коло има улогу техничког сабирача.