Elementi elektronike – JANUAR 2017 - REŠENJA

3.

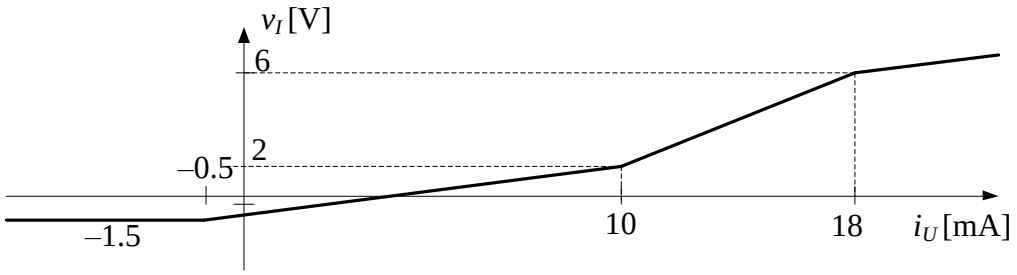
$$i_U < \frac{V_D - \frac{V_Z}{2}}{R} = -0.5\,\text{mA} \qquad \text{D1 off, DZ zener}$$

$$-0.5\,\text{mA} \le i_U < \frac{3V_{CC} - 2V_Z + V_D}{R} = 10\,\text{mA} \qquad \text{D1 on, DZ zener}$$

$$10\,\text{mA} \le i_U < \frac{3(V_{CC} + V_D)}{R} = 18\,\text{mA} \qquad \text{D1 on, DZ off}$$

$$18\,\text{mA} \le i_U \qquad \text{D1 on, DZ dioda}$$

$$v_I = \begin{cases} \dfrac{-V_Z}{2} & i_U < -0.5\,\text{mA} \\ \dfrac{-V_Z - V_D + Ri_U}{3} & -0.5\,\text{mA} \le i_U < 10\,\text{mA} \\ \dfrac{-V_{CC} - V_D + Ri_U}{2} & 10\,\text{mA} \le i_U < 18\,\text{mA} \\ \dfrac{Ri_U}{3} & 18\,\text{mA} \le i_U \end{cases} = \begin{cases} -1.5\,\text{V} & i_U < -0.5\,\text{mA} \\ -\dfrac{4}{3}\,\text{V} + \dfrac{1\text{k}\Omega \cdot i_U}{3} & -0.5\,\text{mA} \le i_U < 10\,\text{mA} \\ -3\,\text{V} + \dfrac{1\text{k}\Omega \cdot i_U}{2} & 10\,\text{mA} \le i_U < 18\,\text{mA} \\ \dfrac{1\text{k}\Omega \cdot i_U}{3} & 18\,\text{mA} \le i_U \end{cases}$$



4.

a) $I_C = 9.9\ \text{mA}$.

b) $A_v = \dfrac{v_p}{v_g} = -\dfrac{g_m + \dfrac{1}{R_B}}{\dfrac{1}{R_P} + \dfrac{1}{R_B}}$,

$$R_u = \frac{1}{\dfrac{1}{r_\pi} + \dfrac{1 - A_v}{R_B}} .$$

c) $g_m = \dfrac{I_C}{V_T} = 396\ \text{mS}$,

$A_v = -360$,

$R_u = 25\ \Omega$.

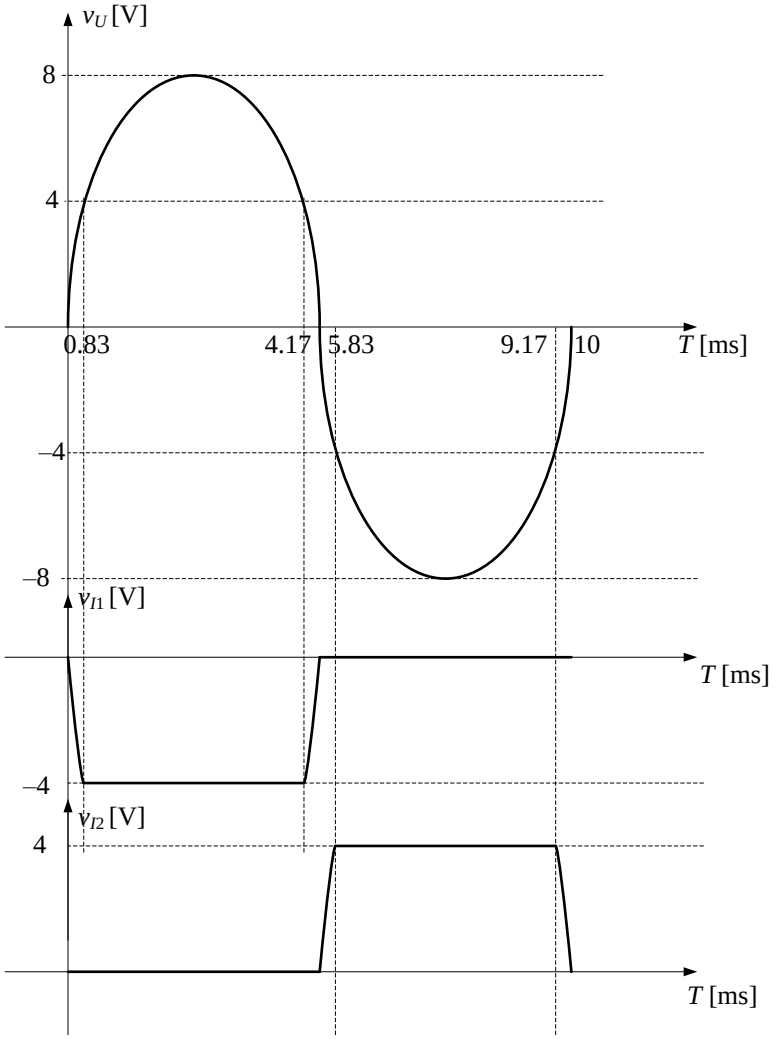
7. Za pozitivne ulazne napone vodi dioda D_1 a isključena je dioda D_2. Napon v_{I1} je invertovan ulazni napon, dok je napon v_{I2} jednak nuli. Napon na izlazu operacionog pojačavača je

$$v_{IOP} = -v_U - V_D$$

Za negativne ulazne napone vodi dioda D_2 a isključena je dioda D_1. Napon v_{I2} je invertovan ulazni napon, dok je napon v_{I1} jednak nuli. Napon na izlazu operacionog pojačavača je

$$v_{IOP} = -v_U + V_D$$

Gornje važi ako operacioni pojačavač nije u zasićenju, odnosno ako je izlazni napon operacionog pojačavača između pozitivnog i negativnog napona napajanja, to jest ako je ulazni napon između –4 V i +4 V.



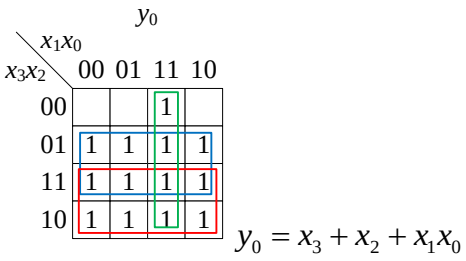
Da bi operacioni pojačavač bio van zasićeja mora uvek važiti
$-V_{CC} \le v_{IOP} \le V_{CC}$
Za $v_U > 0$ ovo postaje $-V_{CC} \le -v_U - V_D \le V_{CC}$, $V_{CC} - V_D \ge v_U \ge -V_{CC} - V_D$, odakle se dobija
$v_U \le 4$ V
Za $v_U < 0$ ovo postaje $-V_{CC} \le -v_U + V_D \le V_{CC}$, $V_{CC} + V_D \ge v_U \ge -V_{CC} + V_D$, odakle se dobija
$v_U \ge -4$ V
Granična amplituda ulaznog napona je 4 V.

8. a)

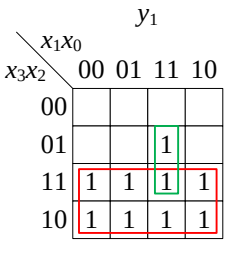
x_3	x_2	x_1	x_0	y_0	y_1	y_2	y_3
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0
0	0	1	0	0	0	0	0
0	0	1	1	1	0	0	0
0	1	0	0	1	0	0	0
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	0
0	1	1	1	1	1	0	0
1	0	0	0	1	1	0	0
1	0	0	1	1	1	0	0
1	0	1	0	1	1	0	0
1	0	1	1	1	1	1	0
1	1	0	0	1	1	1	0
1	1	0	1	1	1	1	0
1	1	1	0	1	1	1	0

1	1	1	1	1	1	1	1

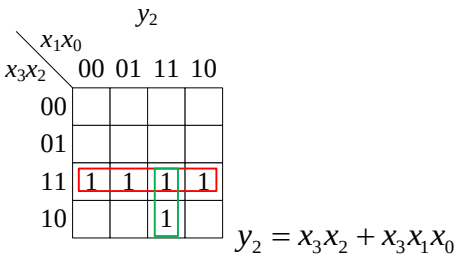
b)



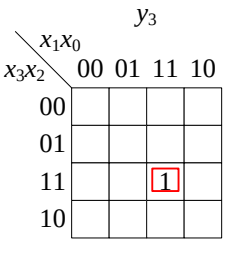
$y_0 = x_3 + x_2 + x_1x_0$



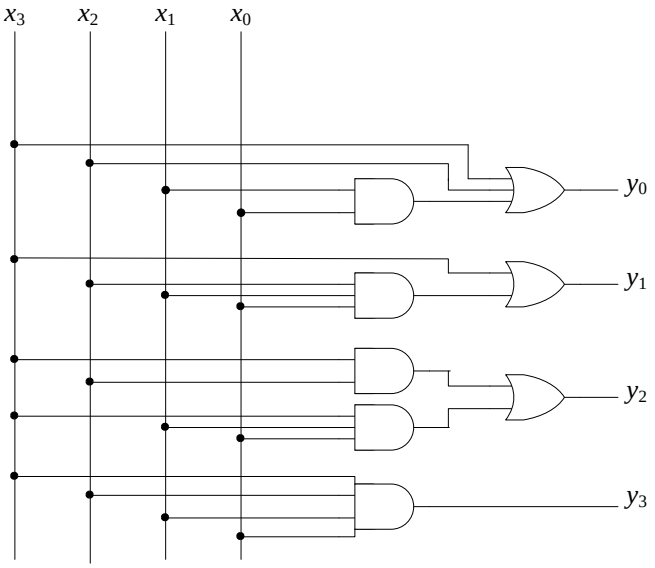
$y_1 = x_3 + x_2x_1x_0$



$y_2 = x_3x_2 + x_3x_1x_0$



$y_3 = x_3x_2x_1x_0$



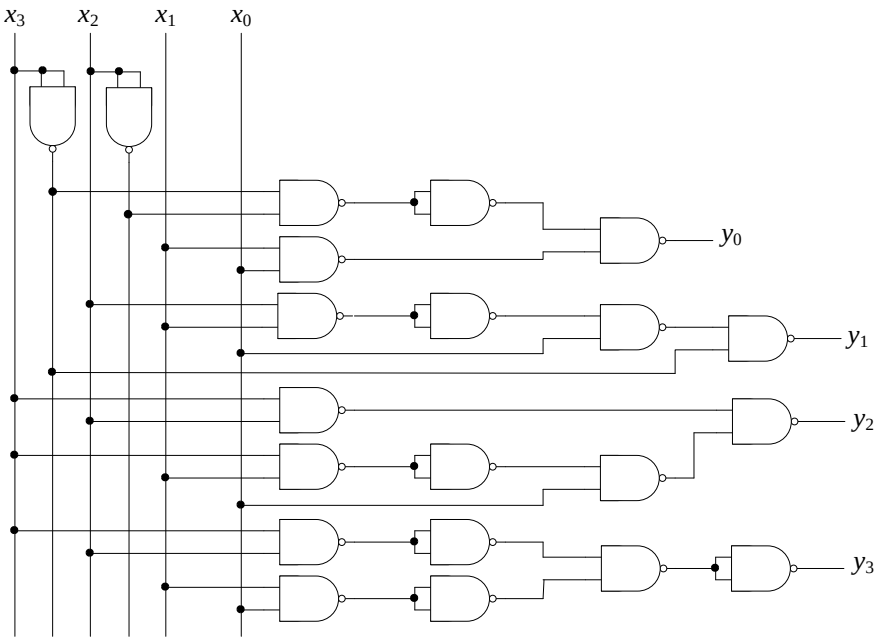
c)

$$y_0 = x_3 + x_2 + x_1x_0 = \overline{\overline{x_3} + \overline{x_2} + \overline{x_1x_0}} = x_3 \cdot x_2 \cdot \overline{x_1x_0} = x_3 \cdot x_2 \cdot \overline{x_1 \cdot x_0}$$

$$y_1 = x_3 + x_2x_1x_0 = \overline{\overline{x_3} + \overline{x_2x_1x_0}} = x_3 \cdot \overline{x_2x_1x_0} = x_3 \cdot \overline{x_2x_1 \cdot x_0}$$

$$y_2 = x_3x_2 + x_3x_1x_0 = \overline{\overline{x_3x_2} + \overline{x_3x_1x_0}} = x_3x_2 \cdot \overline{x_3x_1x_0} = x_3x_2 \cdot \overline{x_3x_1 \cdot x_0}$$

$$y_3 = x_3x_2x_1x_0 = \overline{\overline{x_3x_2x_1x_0}} = x_3x_2 \cdot \overline{x_1x_0}$$



9.