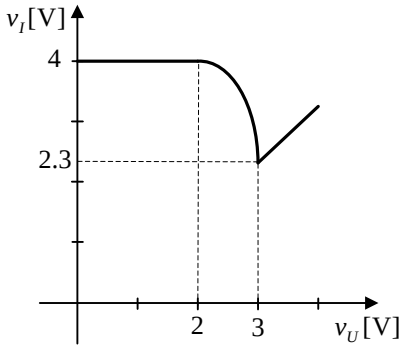
Elementi elektronike jun 2017 – rešenja

2.

$$v_I = \begin{cases} V_{DD} & 0 \le v_U \le V_t \\ V_{DD} - \dfrac{R_D k_n}{2}\left(v_U - V_t\right)^2 & V_t \le v_U \le 3\text{V} \\ v_U - V_D & 3\text{V} \le v_U \le 4\text{V} \end{cases}$$

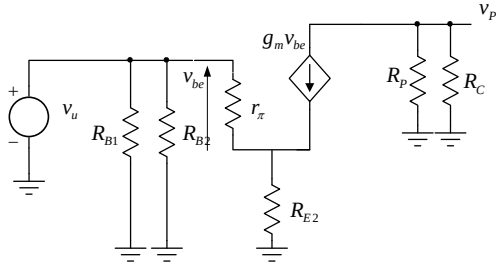


3.

Sa šeme za male signale (Slika 1)

$$v_p = -\left(R_P \,||\, R_C\right) g_m v_{be}$$

$$v_{be} = v_u - v_e$$



Slika 1

$$v_e = R_{E2}\left(\frac{v_{be}}{r_\pi} + g_m v_{be}\right) = R_{E2}\left(v_u\left(\frac{1}{r_\pi} + g_m\right) - v_e\left(\frac{1}{r_\pi} + g_m\right)\right)$$

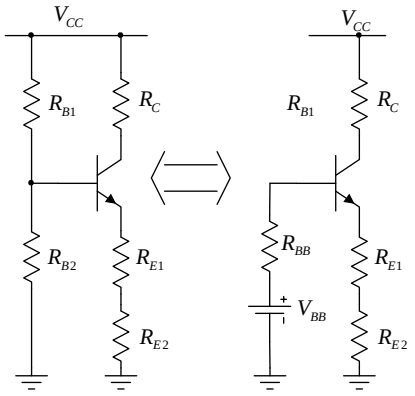
$$v_e = \frac{\dfrac{R_{E2}}{r_\pi} + g_m R_{E2}}{1 + \dfrac{R_{E2}}{r_\pi} + g_m R_{E2}} v_u = \frac{R_{E2}\left(1 + g_m r_\pi\right)}{R_{E2}\left(1 + g_m r_\pi\right) + r_\pi} v_u$$

$$v_p = -\left(R_P \,||\, R_C\right) g_m \frac{r_\pi}{R_{E2}\left(1+\beta\right) + r_\pi} v_u$$

$$A_V = -\left(R_P \,||\, R_C\right) \frac{\beta}{R_{E2}\left(1+\beta\right) + r_\pi}$$

$$r_\pi = -\left(R_P \,||\, R_C\right)\frac{\beta}{A_V} - R_{E2}\left(1+\beta\right) = 6566.7\ \Omega = \frac{\beta V_T}{I_C}$$

$$I_C = \frac{\beta V_T}{r_\pi} = 380.71\,\mu\text{A}$$



Slika 2

Sa šeme za veliki signal (Slika 2.):

$$V_{BB} = \frac{R_{B1}}{R_{B1} + R_{B2}} V_{CC} = 6\text{V}$$

$$R_{BB} = R_{B1} \,||\, R_{B2} = 25\text{k}\Omega$$

$$V_{BB} = R_{BB} \frac{I_E}{1+\beta} + V_{BE} + \left(R_{E1} + R_{E2}\right) I_E$$

$$I_E = \frac{V_{BB} - V_{BE}}{\frac{R_{BB}}{1+\beta} + R_{E1} + R_{E2}}$$

$$I_C = \frac{\beta}{1+\beta} I_E = \frac{\beta}{1+\beta} \frac{V_{BB} - V_{BE}}{\frac{R_{BB}}{1+\beta} + R_{E1} + R_{E2}}$$

$$R_{E1} = \frac{\beta}{1+\beta} \frac{V_{BB} - V_{BE}}{I_C} - \frac{R_{BB}}{1+\beta} - R_{E2} = 13.436\,\text{k}\Omega$$

6.

$$v_I = \begin{cases} V_{CC} - V_D & v_U \le -V_{CC} + V_D \\ -v_U & -V_{CC} + V_D < v_U \le 0 \\ v_U & 0 < v_U \end{cases}$$

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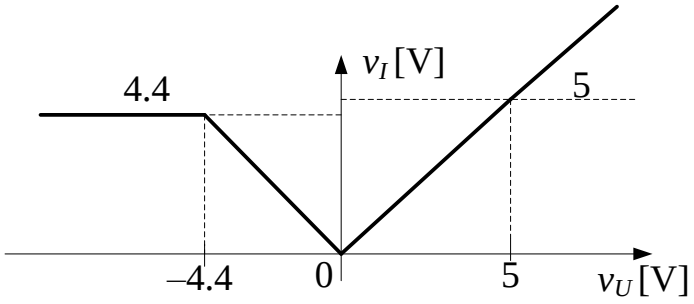
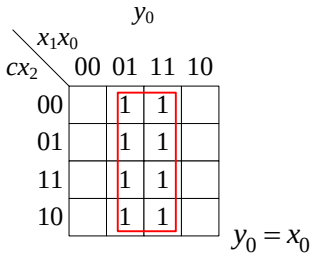


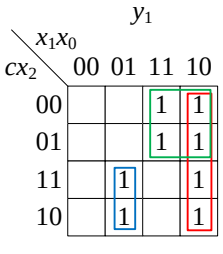
7. a)

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

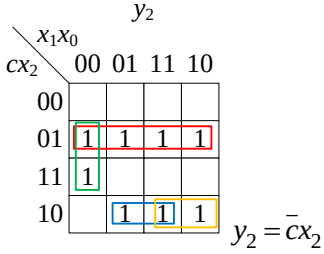
c)



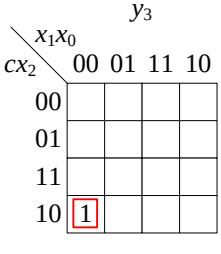
$y_0 = x_0$



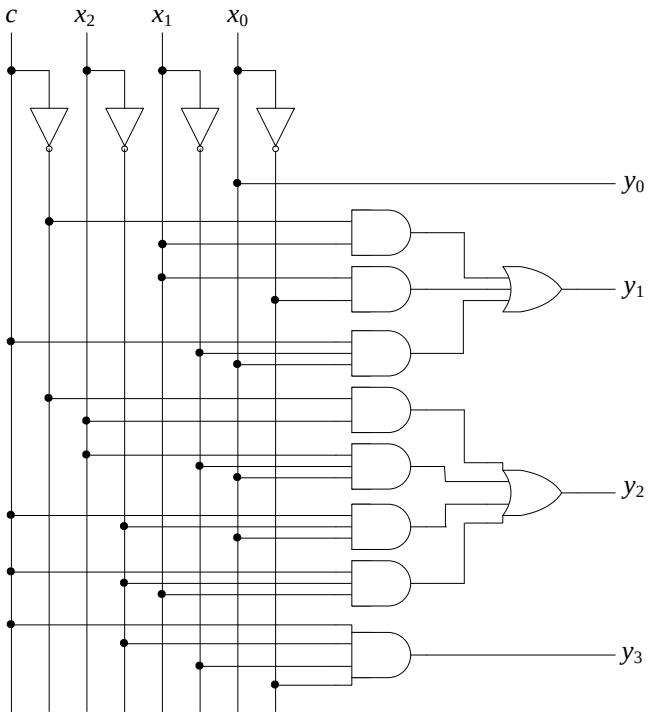
$y_1 = \bar{c}x_1 + x_1\overline{x_0} + c\overline{x_1}x_0$



$y_2 = \bar{c}x_2 + x_2\overline{x_1}\,\overline{x_0} + c\overline{x_2}x_0 + c\overline{x_2}x_1$



$y_3 = c\overline{x_2}\,\overline{x_1}\,\overline{x_0}$



d)

$$y_0 = x_0$$

$$y_1 = \bar{c}x_1 + x_1\bar{x_0} + x_3\bar{x_1}x_0 = \overline{\overline{cx_1} + x_1\bar{x_0} + c\bar{x_1}x_0} = \overline{\bar{c}x_1}\cdot\overline{x_1\bar{x_0}}\cdot\overline{c\bar{x_1}x_0} =$$

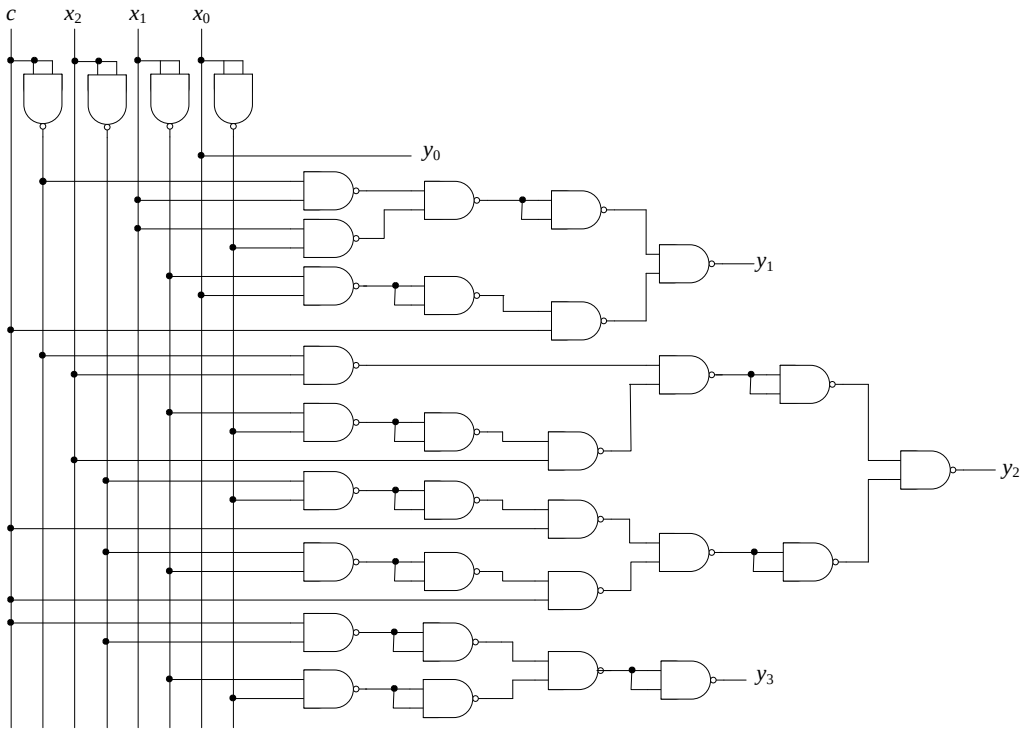
$$= \overline{\left(\overline{\bar{c}x_1}\cdot\overline{x_1\bar{x_0}}\right)\cdot\overline{c\left(\overline{\bar{x_1}x_0}\right)}} = \overline{\bar{c}x_1}\cdot\overline{x_1\bar{x_0}}\cdot\overline{c\bar{x_1}x_0}$$

$$y_2 = \bar{c}x_2 + x_2\bar{x_1}\bar{x_0} + c\bar{x_2}x_0 + c\bar{x_2}x_1 = \overline{\overline{cx_2} + x_2\bar{x_1}\bar{x_0} + c\bar{x_2}x_0 + c\bar{x_2}x_1} =$$

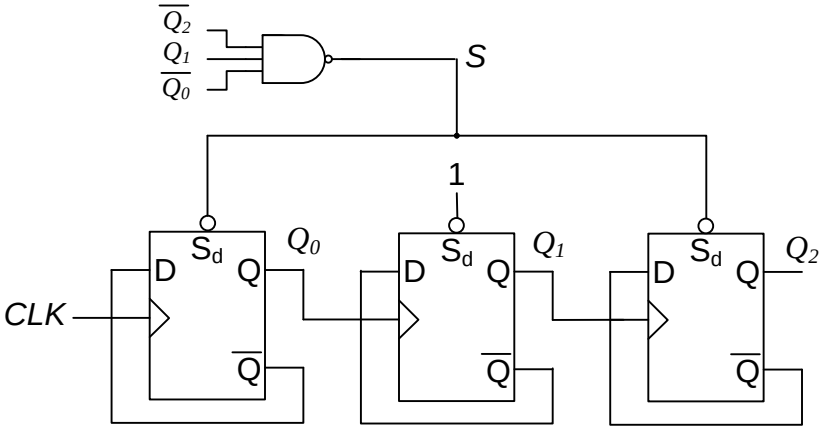
$$= \overline{\bar{c}x_2}\cdot\overline{x_2\bar{x_1}\bar{x_0}}\cdot\overline{c\bar{x_2}x_0}\cdot\overline{c\bar{x_2}x_1} = \overline{\left(\overline{\bar{c}x_2}\cdot\overline{x_2\left(\bar{x_1}\bar{x_0}\right)}\right)\cdot\left(\overline{c\left(\bar{x_2}x_0\right)}\cdot\overline{c\left(\bar{x_2}x_1\right)}\right)} =$$

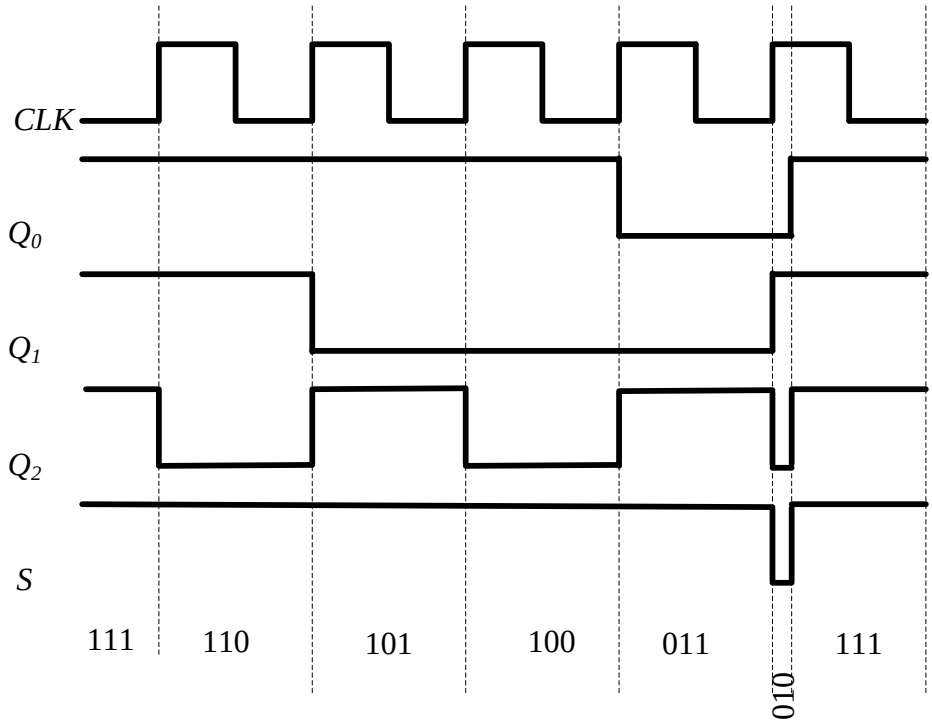
$$= \overline{\bar{c}\cdot x_2}\cdot\overline{x_2\cdot\bar{x_1}\cdot\bar{x_0}}\cdot\overline{c\cdot\bar{x_2}\cdot x_0}\cdot\overline{c\cdot\bar{x_2}\cdot x_1}$$

$$y_3 = c\bar{x_2}\bar{x_1}\bar{x_0} = \overline{\overline{c\bar{x_2}\bar{x_1}\bar{x_0}}} = \overline{\left(\overline{c\bar{x_2}}\right)\left(\overline{\bar{x_1}\bar{x_0}}\right)} = \overline{c\cdot x_2}\cdot\overline{\bar{x_1}\cdot\bar{x_0}}$$



8.




CLK
Q0
Q1
Q2
S
111
110
101
100
011
010
111