REŠENJA:

1. $R_C = 0,4833\text{k}\Omega,\ \ R_{B1} = 7,742\text{k}\Omega;\ \ \beta = \infty:\ V_{CQ} = 1,2419\text{V},\ \ I_{CQ}$=3,5676mA

2.

$$I_{C4} = I_4 = I_3 = \frac{V_{CC} - V_{EE} - V_{BE}}{R_1} = 1\text{mA};\ I_1 = I_2 = 0,5\text{mA};\ g_{m1} = g_{m2} = \frac{I_1}{V_T} = 20\text{mS}$$

$$A_d = \frac{v_i}{v_{u1} - v_{u2}} = \frac{g_{m2}R_2}{2};\ A_s \cong -\frac{R_2}{2r_{ce4}};\ \rho = \left|\frac{A_d}{A_s}\right| \cong g_{m2}r_{ce4} = 1000$$

3.

$$R_{ur}\big|_{a=0} = 5\text{k}\Omega + R_{ul} + \left[1\text{k}\Omega \,||\, \left(4\text{k}\Omega + R_{izl} \,||\, 5\text{k}\Omega\right)\right] = 10\text{k}\Omega + \left(1\text{k}\Omega \,||\, 6,5\text{k}\Omega\right) = 10,867\text{k}\Omega$$

$$T\big|_{KS} = a \times \frac{R_{ul}}{5\text{k}\Omega + R_{ul}} \times \frac{\left(5\text{k}\Omega + R_{ul}\right) || \, 1\text{k}\Omega}{\left(5\text{k}\Omega + R_{ul}\right) || \, 1\text{k}\Omega + 4\text{k}\Omega} \times \frac{\left[\left(5\text{k}\Omega + R_{ul}\right) || \, 1\text{k}\Omega + 4\text{k}\Omega\right] || \, 5\text{k}\Omega}{5\text{k}\Omega + \left[\left(5\text{k}\Omega + R_{ul}\right) || \, 1\text{k}\Omega + 4\text{k}\Omega\right] || \, 5\text{k}\Omega}$$

$$= 20 \times \frac{1}{2} \times \frac{0,909}{4,909} \times \frac{4,909\text{k}\Omega \,||\, 5\text{k}\Omega}{5\text{k}\Omega + 4,909\text{k}\Omega \,||\, 5\text{k}\Omega} = 0,61288$$

$$T\big|_{OV} = 0$$

$$R_{ur} = R_{ur}\big|_{A=0} \times \frac{1 + T\big|_{KS}}{1 + T\big|_{OV}} = 10,867\text{k}\Omega \times \frac{1,61288}{1} = 17,527\text{k}\Omega$$

4.

I $0 \le v_U < V_Z$, DZ1, DZ2, D1 OFF

$$i_{Z1} = i_{Z2} = i_{D1} = 0$$
$$v_I = v_U$$

II $V_Z \le v_U \le 12\text{V}$, DZ2 ON, DZ1, D1, OFF

$$v_I = \frac{v_U - V_Z}{2R}R + V_Z = \frac{v_U + V_Z}{2}$$
$$i_{Z2} = \frac{v_U - V_Z}{2R},\ i_{Z1} = i_{D1} = 0$$

III $V_1 \le v_U < 0$, DZ1, DZ2, D1 OFF

$$i_{Z1} = i_{Z2} = i_{D1} = 0$$
$$v_I = v_U$$

$$v_U = V_1 \Rightarrow DZ2 \text{ ON } \Rightarrow\ V_1 = -V_D$$

IV $V_2 \le v_U < V_1$, DZ2 ON, DZ1, D1 OFF

$$v_I = \frac{v_U + V_D}{2R}R - V_D = \frac{v_U - V_D}{2}$$
$$i_{Z2} = \frac{v_U + V_D}{2R},\ \ i_{Z1} = i_{D1} = 0$$

$$v_U = V_2 \Rightarrow \text{ DZ1, D1 ON } \Rightarrow \frac{V_2 - V_D}{2} = -V_Z - V_D \Rightarrow V_2 = -2V_Z - V_D$$

V $-12\text{V} \le v_U < V_2$, DZ2, DZ1, D1 ON

$$v_I = -V_D - V_Z$$

$$i_{Z2} = \frac{v_I + V_D}{R} = -\frac{V_Z}{R}$$

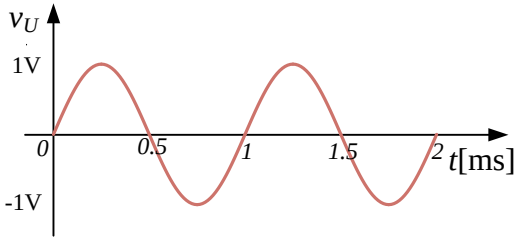
$$i_{Z1} = i_{D1} = \frac{v_I - v_U}{R} + i_{Z2} = \frac{-V_D - V_Z - v_U - V_Z}{R} = \frac{-V_D - 2V_Z}{R} - \frac{v_U}{R}$$

5. a) $v_U > 0$ D1 on, D2 off $\Rightarrow v_{I1} = 0, v_{I2} = v_U / 2$

$v_U < 0$ D1 off, D2 on $\Rightarrow v_{I1} = -v_U, v_{I2} = 0$

$$v_{I1} = \begin{cases} -v_U, -5\text{V} \le v_U < 0 \\ 0, 0 \le v_U \le +5\text{V} \end{cases}, \quad v_{I2} = \begin{cases} 0, -5\text{V} \le v_U < 0 \\ v_U / 2, 0 \le v_U \le +5\text{V} \end{cases}$$

$$v_{IOP} = \begin{cases} -v_U + V_D, -5\text{V} \le v_U < 0 \\ -v_U - V_D, 0 \le v_U \le +5\text{V} \end{cases},$$



b) $v_I = -(v_{I1} / 2 + v_{I2})$

c) $v_I = \begin{cases} v_U / 2, -1\text{V} \le v_U < 0 \\ -v_U / 2, 0 \le v_U \le +1\text{V} \end{cases}$