PISMENI ISPIT - ELEKTRONIKA 1 – 08.02.2012. rješenja

1.

a) $U_K = \ln(N_A * N_D / n_i^2) = \cdots = 0{,}731\ \text{V}$

b) $n_{op} = \frac{n_i^2}{N_A} = \cdots = 1{,}05e5\ \text{cm}^{-2}$

$p_{on} = \frac{n_i^2}{N_D} = \cdots = 1{,}05e3\ \text{cm}^{-2}$

$I_S = q * S * \left(D_n * \frac{n_{op}}{L_n} + D_p * \frac{p_{on}}{w_n} \right) = \cdots = 2{,}55e-12\ \text{mA}$

c) $I = I_S * \left(\exp\left(\frac{U}{m U_T} \right) - 1 \right) = \cdots = 4{,}39\ \text{mA}$ (1 bod)

d) $r_d = \frac{U_T}{I + I_S} = \cdots = 5{,}89\ \Omega$ (2 boda)

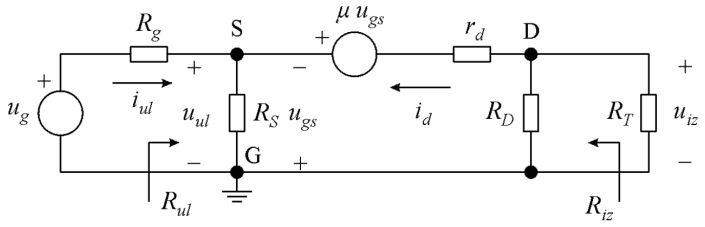
2.

a)

$$R_S = \frac{U_{GG} - U_{GSQ}}{I_{DQ}} = \frac{4{,}36 - 2{,}35}{2 \cdot 10^{-3}} = 1\ \text{k}\Omega$$

$$U_{DSQ} = U_{DD} - I_{DQ}(R_D + R_S) = 15 - 2 \cdot 10^{-3}(2700 + 1000) = 7{,}6\ \text{V}$$

b)



c)

$$A_V = \frac{u_{iz}}{u_{ul}} = \frac{(1+\mu)(R_D \parallel R_T)}{r_d + R_D \parallel R_T} \approx \frac{g_m r_d (R_D \parallel R_T)}{r_d + R_D \parallel R_T} = g_m (r_d \parallel R_D \parallel R_T) = 5{,}7$$

d)

$$R_{ul} = R_S \parallel \frac{r_d + R_D \parallel R_T}{1+\mu} \approx R_S \parallel \frac{1}{g_m} = 250\ \Omega$$

e)

$$R_{iz} = R_D \parallel \left[r_d + (1+\mu)\left(R_S \parallel R_g \right) \right] = 2670\ \Omega \approx R_D$$

3.

a)

$$\gamma = \frac{I_{nE1}}{-I_{E1}} \Rightarrow I_{nE1} = \gamma \cdot (-I_{E1}) = 5,445 \text{ mA} \qquad \beta_1^* = \frac{I_{nC1}}{I_{nE1}} \Rightarrow I_{nC1} = \beta^* \cdot I_{nE1} = 5,391 \text{ mA}\ ,\ I_{C1} = I_{nC1}$$

$$I_{pE1} = I_{E1} - I_{nE1} = 55\ \mu\text{A} \qquad I_{B1} = -I_{E1} - I_{C1} = 109\ \mu\text{A} \qquad I_{R1} = I_{B1} - I_{pE1} = 54\ \mu\text{A}$$

b)

$$\Rightarrow \frac{I_{pE2}}{I_{pE1}} = 1$$

$$\Rightarrow I_{R2} = I_{R1} \frac{w_{B2}}{w_{B1}} = 48,6\mu A$$

$$\Rightarrow I_{nE2} = I_{nE1} \frac{w_{B1}}{w_{B2}} = 6,05mA$$

$$I_{E2} = -I_{nE2} - I_{pE2} = 6,105\text{mA} \qquad I_{B2} = I_{pE2} + I_{R2} = 103,6\mu\text{A} \qquad I_{C2} = I_{nE2} - I_{R2} = 6\text{mA}$$

c)

$$\gamma = \frac{I_{nE2}}{-I_{E2}} = 0,991 \qquad \beta_2 = \frac{I_{C2}}{I_{B2}} = 58,9 \qquad \alpha_2 = \frac{\beta_2}{1+\beta_2} = 0,983$$

4.

a)

$$\boldsymbol{R_E} = \frac{U_{EQ}}{I_{EQ}} = \frac{U_{EQ}}{I_{CQ} + I_{BQ}} = \frac{U_{EQ}}{I_{CQ} + \frac{I_{CQ}}{\beta}} = \frac{6\ V}{1{,}01\ *\ 2\ mA} = \boldsymbol{2,97\ k}$$

$$U_{BQ} = U_{EQ} + U_\gamma = 6{,}7\ V$$

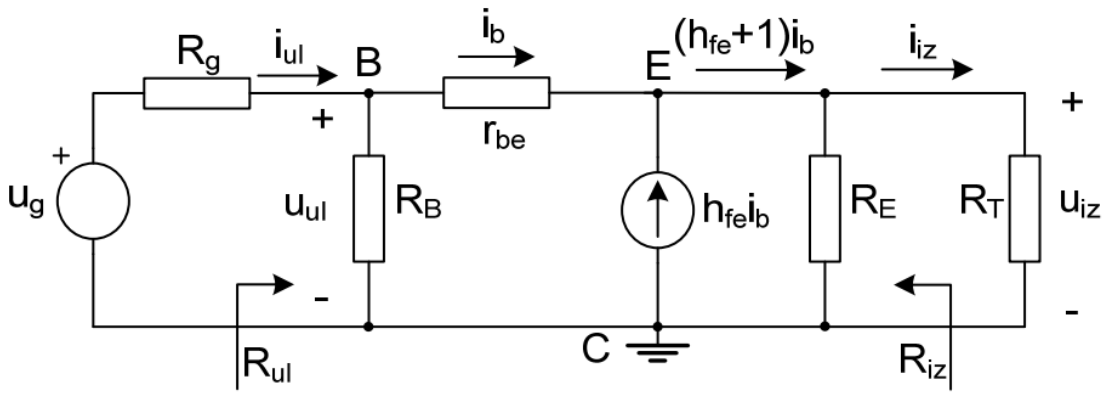
$$\boldsymbol{R_2} = \frac{U_{BQ}}{I_{R2}} = \frac{6{,}7}{10 * \frac{I_{CQ}}{\beta}} = \boldsymbol{33,5\ k} \qquad \boldsymbol{R_1} = \frac{U_{CC} - U_{BQ}}{11 * \frac{I_{CQ}}{\beta}} = \boldsymbol{24,1\ k} \qquad \boldsymbol{r_{be}} = \frac{U_T}{\frac{I_{CQ}}{\beta}} = \boldsymbol{1,25\ k}$$

b)

$$R_{ul} = R_{ul}^{'} || R_B$$

$$R_{ul}^{'} = r_{be} + (h_{fe} + 1)(R_E || R_T) = 1{,}25\ k + 101 * 1{,}195\ k = 121{,}96\ k$$

$$\boldsymbol{R_{ul} = 12,56\ k}$$



$$\boldsymbol{A_I} = \frac{i_{iz}}{i_{ul}} = \frac{R_E}{R_E + R_T} * \frac{R_B}{R_B + R_{ul}'} * \left(h_{fe} + 1\right) = \cdots = \mathbf{6,21}$$

5.

a)

$$U_{IZ} = \left(1 + \frac{R_4}{R_3}\right) U_4 - \frac{R_4}{R_3}\left(1 + \frac{R_2}{R_1}\right) \frac{U_1 + U_2 + U_3}{3}.$$

b)

$$U_{IZ} = = \left(1 + \frac{4}{2}\right) \cdot 0{,}8 - \frac{4}{2} \cdot \left(1 + \frac{5}{1}\right) \cdot \frac{0{,}4 + 0{,}2 + 0{,}6}{3} = -2{,}4 \text{ V}.$$

c)

$$U_{IZ} = = \left(1 + \frac{6}{2}\right) \cdot 0{,}8 - \frac{6}{2} \cdot \left(1 + \frac{1}{1}\right) \cdot \frac{0{,}4 + 0{,}2 + 0{,}6}{3} = 0{,}8 \text{ V}.$$