# ZAVRŠNI ISPIT iz ELEKTRONIKE 1 - rješenje

| Grupa | A | B | C | D |
|-------|---|---|---|---|
| 1. | C | B | E | A |
| 2. | C | A | D | B |
| 3. | C | B | D | E |
| 4. | A | C | B | D |
| 5. | C | C | D | A |
| 6. | B | E | A | C |
| 7. | D | E | B | C |

ZADACI :

1.

a) $U_{GSQ} = 1.63$ V

$I_{DQ} = 1$ mA

$U_{DSQ} = 10$ V

$g_m = 3.3$ mA/V (3.15 mA/V)

$r_d = 200$ kΩ

$\mu = 660$ (600)

b) $A_v = \dfrac{U_{iz}}{U_{ul}} = -\dfrac{\mu R_D \| R_T}{R_D \| R_T + r_d + (1+\mu) R_{S1}} = \dfrac{660 \cdot 4,8k}{4,8k + 200k + 661 \cdot 1k} = -3,66(-3,57)$

$A_{vg} = \dfrac{U_{iz}}{U_g} = A_v \dfrac{R_{GG}}{R_g + R_{GG}} = -4,37 \dfrac{81,8k}{2k + 81,8k} = -3,56(-3,48)$
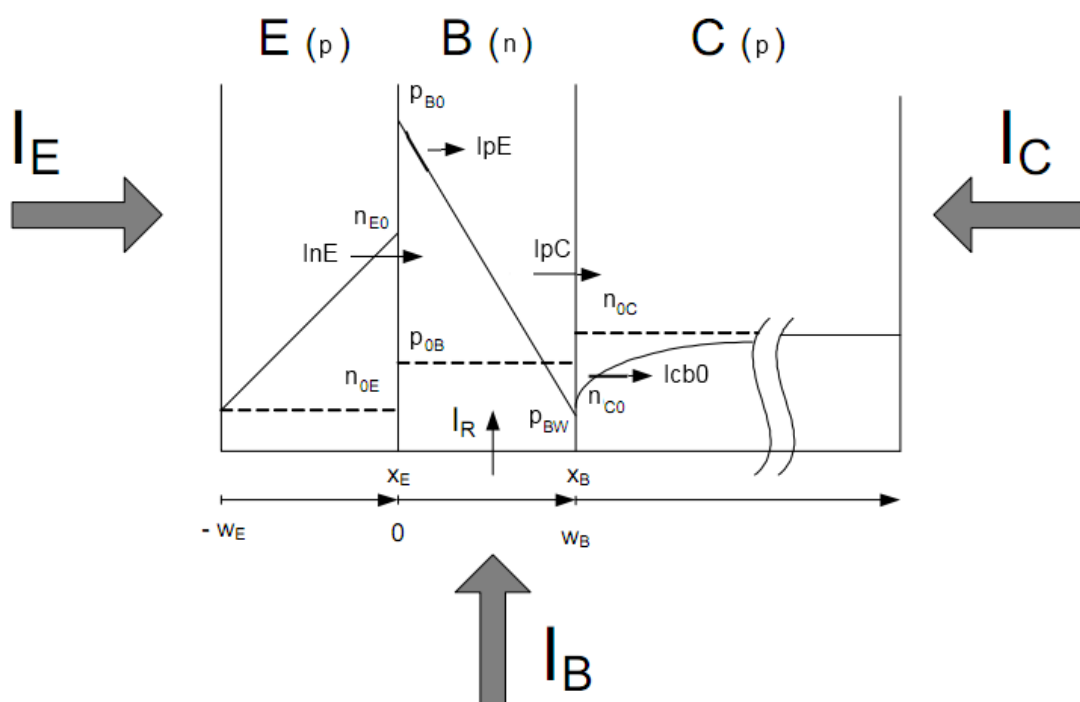
c)

$R_{ul} = R_{GG} = 81,8k$

$R_{iz}:\ u_{iz} = i(r_d + R_{S1}) - \mu u_{gs},\ u_{gs} = -i R_{S1}$

$R_{iz} = R_D \| (r_d + (1+\mu) R_{S1}) \approx 8k$

2.

a)



$$n_{0E} = \frac{n_i^2}{N_{AE}} = \frac{(1,45e10)^2}{2e18} = 1,05 * 10^2 \text{ cm}^{-3}$$

$$p_{0B} = \frac{n_i^2}{N_{DB}} = \frac{(1,45e10)^2}{2e16} = 1,05 * 10^4 \text{ cm}^{-3}$$

$$n_{E0} = n_{0E} \exp\left(-\frac{U_{BE}}{U_T}\right) = 1,826 * 10^{11} \text{ cm}^{-3} \ (n_{E0} = 3,764 * 10^{11} \text{ cm}^{-3} \text{ za } U_T = 25 \text{ mV})$$

$$p_{B0} = p_{0B} \exp\left(-\frac{U_{BE}}{U_T}\right) = 1,826 * 10^{13} \text{ cm}^{-3} \ (p_{B0} = 3,76 * 10^{13} \text{ cm}^{-3} \text{ za } U_T = 25 \text{ mV})$$

b)

$$\boldsymbol{I_{nE}} = q\, SD_{nE} \frac{n_{E0}}{w_e} = 1,6 * 10^{-19} * 2 * 10^{-2} * 12,408 * \frac{1,826 * 10^{11}}{1,7 * 10^{-4}} = \boldsymbol{42,648\ \mu A}$$

$(I_{nE} = 85,022\ \mu A \text{ za } U_T = 25 \text{ mV})$

$$\boldsymbol{I_{pE}} = q\, SD_{pB} \frac{p_{B0}}{w_e} = 1,6 * 10^{-19} * 2 * 10^{-2} * 7,238 * \frac{1,826 * 10^{13}}{1 * 10^{-4}} = \boldsymbol{4,23\ mA}$$

$(I_{pE} = 8,431 \text{ mA za } U_T = 25 \text{ mV})$

$$\boldsymbol{I_{pC}} = \beta^* * I_{pE} = \boldsymbol{4,223\ mA} \ (I_{pC} = 8,416 \text{ mA za } U_T = 25 \text{ mV})$$

$$\boldsymbol{I_R} = I_{pE} - I_{pC} = \boldsymbol{7,19\ \mu A} \ (I_R = 15\ \mu A \text{ za } U_T = 25 \text{ mV})$$

$$\boldsymbol{I_E} = I_{nE} + I_{pE} = \boldsymbol{4,27\ mA} \ (I_E = 8,516 \text{ mA za } U_T = 25 \text{ mV})$$

$$I_B = -I_{nE} - I_R - I_{CB0} = -I_{nE} - I_R = -49,838 \ \mu A \ (I_B = 100 \ \mu A \ za \ U_T = 25 \ mV)$$

$$I_C = -I_{pC} - I_{CB0} = -I_{pC} = -4,223 \ mA \ (I_C = -8,416 \ mA \ za \ U_T = 25 \ mV)$$

c)

$$\gamma = \frac{I_{pE}}{I_{pE} + I_{nE}} = 0,9906 \ (0,99002), \ \alpha = \gamma \beta^* = 0,98895 \ (0,98823), \ \beta = 89 \ (84)$$

3.

    a) $I_{CQ} = 2.12$ mA
       $U_{CEQ} = 6.34$ V
       $I_{BQ} = 21.2 \ \mu A$
       $r_{be} = 1180 \ \Omega$

    b) $u_{iz}(t) = 14.6 \ \sin(\omega t) \ mV$
       $i_{ul}(t) = 9.885 \sin(\omega t) \ \mu A$
       $i_{iz}(t) = 4.866 \sin(\omega t) \ \mu A$

       $u_{iz}(t) = A_{Vg} * u_g(t)$
       $i_{ul}(t) = u_{ul}(t)/R_{ul}$
       $i_{iz}(t) = u_{iz}(t)/R_T$
       $u_{ul}(t) = u_g(t) * (R_{ul}/(R_{ul} + R_G)$

       $R_{ul} = R_E // r_{be}/(1 + h_{fe})$

4.

$$I_0 = I_1 + I_2$$

$$U_{IZ1} + I_1 R_1 + \frac{U_{IZ1}}{A_1} = 0$$

$$U_{IZ2} + I_2 R_2 + \frac{U_{IZ2}}{A_2} = 0$$

c)    $U_{IZ1} = -0.05$ V
       $U_{IZ2} = -0.1$ V

$$\frac{U_{IZ1}}{A_1} = \frac{U_{IZ2}}{A_2}$$

a) $U_{IZ1} = -\dfrac{A_1 I_0 R_1 R_2}{R_1 (1 + A_2) + R_2 (1 + A_1)}$      b) $U_{IZ2} = -\dfrac{A_2 I_0 R_1 R_2}{R_2 (1 + A_1) + R_1 (1 + A_2)}$