

REŠENJA:

1.

$$a) \quad a_d = \frac{v_i}{v_{u1} - v_{u2}} = \frac{g_{m2}R_2}{2}; \quad a_s \cong -\frac{R_2}{2r_{ds4}}; \quad \rho = \left| \frac{a_d}{a_s} \right| \cong g_{m2}r_{ds4}$$

$$b) \quad \rho = 100\sqrt{2} \cong g_{m2}r_{ds4} = \sqrt{2I_2B} \times \frac{V_{DS4} + V_{A4}}{I_4} \cong \sqrt{I_4B} \times \frac{V_{A4}}{I_4} \quad \Leftarrow (V_{DS4} \square V_{A4})$$

$$\rho = 100\sqrt{2} \cong \sqrt{\frac{B}{I_4}} \times V_{A4} \Rightarrow I_4 = 1\text{mA} = I_3$$

$$I_3 = 1\text{mA} = \frac{B}{2}(V_{GS3} - V_t)^2 \Rightarrow V_{GS3} = 2\text{V} \quad R_1 I_3 + V_{GS3} = V_{DD} - V_{SS} \Rightarrow R_1 = 8\text{k}\Omega$$

$$I_1 = I_2 = I_4/2 = 0,5\text{mA} \quad V_{IQ} = V_{SS} + R_2 I_2 = -2,5\text{V} \Rightarrow R_2 = (-V_{SS} - 2,5\text{V})/I_2 = 5\text{k}\Omega$$

2. Beleške za predavanja, 9_Izlazni_pojacavacki_stepeni.pdf, slajdovi 6-8 (+ 3-5).

3. Beleške za predavanja, 13_Regulator_(stabilizator)_napona.pdf, slajdovi 2, 3 i 5.

4.

$$a) \quad v_{BE1} = v_{BE2} \Rightarrow I_{C1} = I_{C2} = I_C$$

$$I_R = \frac{V_{CC} - V_{BE}}{R_1}$$

$$\left. \begin{aligned} I_R &= I_{C2} + I_{B2} + I_{B1} = I_C \left(1 + \frac{2}{\beta_F}\right) \\ I_0 &= I_{C1} = I_C \end{aligned} \right\} \Rightarrow I_0 = \frac{I_R}{\left(1 + \frac{2}{\beta_F}\right)} \Rightarrow I_0 = \frac{V_{CC} - V_{BE}}{R_1 \left(1 + \frac{2}{\beta_F}\right)}$$

$$b) \quad v_{CE1} = V_{CC} - I_0 R_P \geq V_{CES} \Rightarrow R_P \leq \frac{V_{CC} - V_{CES}}{I_0}$$

$$\text{za } R_1 = 4,4\text{k}\Omega \quad I_0 = 0,98\text{mA} \text{ pa je } R_P \leq 4,9\text{k}\Omega \Rightarrow R_{P\text{max}} = 4,9\text{k}\Omega$$

$$c) \quad g_m = \frac{I_C}{V_T} = 39,2\text{mS}, \quad r_\pi = \frac{\beta_0}{g_m} = 2,55\text{k}\Omega, \quad r_{ce} = \frac{V_A}{I_C} = 102\text{k}\Omega$$

$$R_R = r_{ce} \parallel \frac{1}{g_m} \parallel r_{\pi1} \parallel r_{\pi2} = 25\Omega$$

5.

a)

$$\left. \begin{aligned} V_{I1} &= -\frac{R_2}{R_1} V_R + \left(1 + \frac{R_2}{R_1}\right) V \\ V_I &= -\frac{R_1}{R_2} V_{I1} + \left(1 + \frac{R_1}{R_2}\right) V \end{aligned} \right\} \Rightarrow V_I = V_R$$

b)

$$v_i = \left(1 + \frac{R_2}{R_1}\right) \cdot -\frac{R_1}{R_2} v_1 + \left(1 + \frac{R_1}{R_2}\right) v_2 = \left(1 + \frac{R_1}{R_2}\right) (v_2 - v_1) = 2\left(1 + \frac{R_1}{R_2}\right) v_2$$

$$a_1 = 2\left(1 + \frac{R_1}{R_2}\right) = 20$$

c) Za $v_1 = v_2$ iz prethodnog izraza se dobija $v_i = 0 \Rightarrow a_2 = 0$

$$d) \text{ Za } v_1 = v_2 = V, \quad V_I = V_R, \quad V_{I1} = -\frac{R_2}{R_1} V_R + \left(1 + \frac{R_2}{R_1}\right) V = \frac{10V - V_R}{9}$$

$$\frac{10V_{\text{min}} - V_R}{9} = V_{OL} \Rightarrow V_{\text{min}} = \frac{9V_{OL} + V_R}{10} = 0,34\text{V}$$

$$V_{\text{max}} = \frac{9V_{OH} + V_R}{10} = 4,66\text{V}$$