REŠENJA:

1.

a) $V_Z = 5,6\text{V}$

b) $I = 0,2\text{W}/5,6\text{V} = 35,7\text{mA};\ \ I_{Z\max} = I = 35,7\text{mA};\ \ I_{R_p}\Big|_{\max} = 101I = 3,6\text{A};\ \ I_{R_p}\Big|_{R_p=0} = 3,6\text{A}$

2.

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

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

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

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

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

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

4. a) i b) $V_E = (R_{E1} + R_{E2})I_C = 5V$

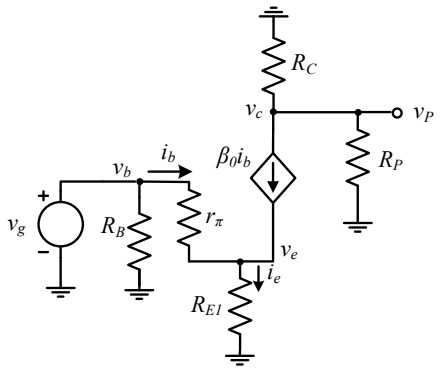
$V_C = V_{CC} - R_C I_C = 9.5V$, $V_{CE} = 4.5V > V_{CES}$ dakle tranzistor radi u DAR-u

$V_B = V_E + V_{BE} = 5.6V$

$V_B = \dfrac{R_2}{R_1 + R_2} V_{CC} \Rightarrow R_2 = \dfrac{R_1}{\dfrac{V_{CC}}{V_B} - 1} = 87.5k\Omega$

$V_P = 0$

c) $r_\pi = \dfrac{\beta_0 V_T}{I_C} = 5k\Omega$, $R_B = R_1 \,||\, R_2 = 46.67k\Omega$



$$\left.\begin{aligned} v_p &= -\beta_0 i_b (R_C \,||\, R_P) \\ i_b &= \frac{v_g}{r_\pi + (1+\beta_0)R_{E1}} \end{aligned}\right\} \Rightarrow v_p = -\frac{\beta_0 (R_C \,||\, R_P)}{r_\pi + (1+\beta_0)R_{E1}} v_g \Rightarrow a_v = \frac{v_p}{v_g} = -\frac{\beta_0 (R_C \,||\, R_P)}{r_\pi + (1+\beta_0)R_{E1}} = -6$$

$R_i = R_C = 5k\Omega$

$R_u = R_B \,||\, (r_\pi + (1+\beta_0)R_{E1}) = 25.35k\Omega$

$$\left.\begin{aligned} i_p &= \frac{v_p}{R_P} \\ i_g &= \frac{v_g}{R_u} \end{aligned}\right\} \Rightarrow a_i = \frac{i_p}{i_g} = \frac{R_u}{R_P}\frac{v_p}{v_g} = -15.2$$

d) $v_B(t) = V_B + v_b(t) = V_B + v_g(t) = (5.6 + 0.5\sin(2\pi ft))V$

$$v_C(t) = V_C + v_c(t) = V_C + a_v v_g(t) = (9.5 - 3\sin(2\pi ft))V$$

$$v_P(t) = V_P + v_p(t) = a_v v_g(t) = -3V\sin(2\pi ft)$$

$$v_E(t) = V_E + v_e(t) = V_E + (1+\beta_0)R_{E1}i_b(t) = V_E + \frac{(1+\beta_0)R_{E1}}{r_\pi + (1+\beta_0)R_{E1}}v_g(t) = (5 + 0.45\sin(2\pi ft))V$$

5.

a)

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

b)

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

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

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

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

$$\frac{10V_{\min} - V_R}{9} = V_{OL} \Rightarrow V_{\min} = \frac{9V_{OL} + V_R}{10} = 0.34\text{V}$$

$$V_{\max} = \frac{9V_{OH} + V_R}{10} = 4.66\text{V}$$