



a)  $V_{cc} = V_{rc} + V_{o1}$

S

$$V_{cc} = I_c \cdot R_c + V_{o1}$$

$$10V = I_c \cdot 50k + 5V$$

$$I_c = 0,1 \text{ mA} = 100 \mu\text{A} \quad I_o = 2I_c = 200 \mu\text{A}$$

b)

S

$$K_{dd} = \frac{V_{o1} - V_{o2}}{V_{i1} - V_{i2}} = \frac{-R_c}{r_e} = \frac{-50k}{0,25k} = -200$$

$$r_e = \frac{V_T}{I_c} = 250 \Omega$$

$$K_{da} = \frac{V_{o2}}{V_{o1} - V_{i2}} = \frac{R_c}{2r_e} = 100$$

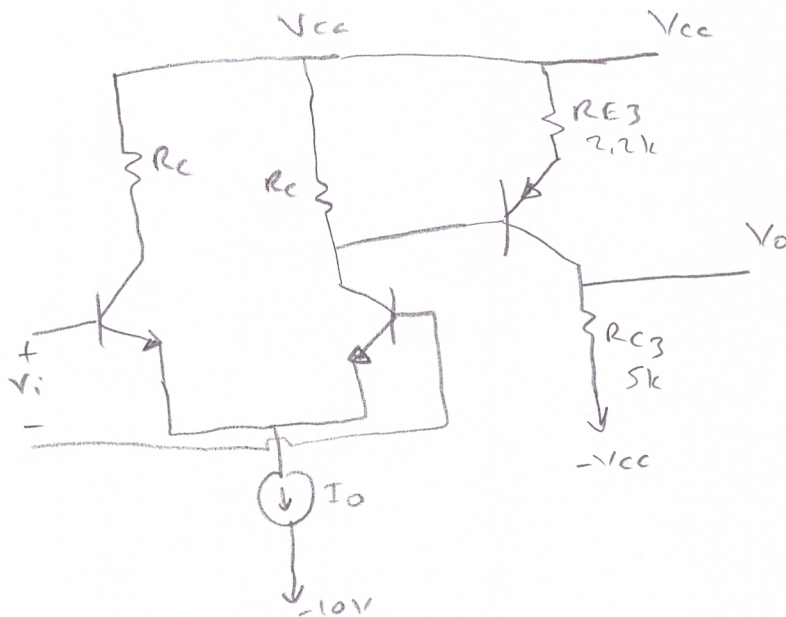
c)

S

$$CMRR = \frac{2R_c}{r_e} = \frac{2 \cdot 250k}{250 \Omega} = 2000 \Rightarrow 66 \text{ dB}$$

d)

S



e)  $\sum K_v = K_{da} \cdot K_{v_{difer}}$

S

$$\downarrow$$

$$\frac{V_o}{V_{o2}}$$

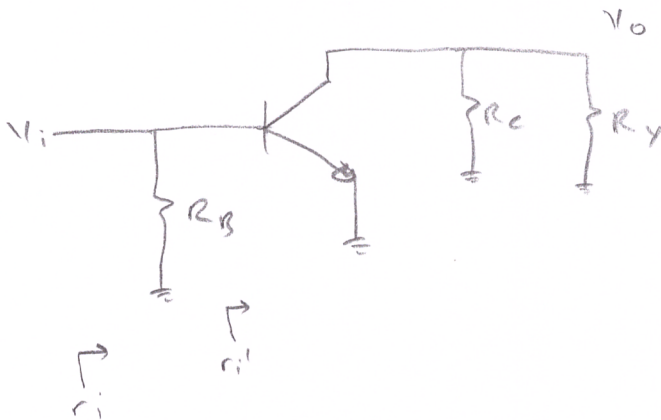
$$\textcircled{2} \quad V_{CC} = V_{R_B} + V_{BE}$$

$$5 a) \quad I_B = \frac{V_{CC} - V_{BE}}{R_B} = 0,0186 \text{ mA} \quad I_C = \beta \cdot I_B = 1,86 \text{ mA}$$

$$V_C = V_{CC} - V_{R_C} = V_{CC} - R_C \cdot I_C = 5,9 \text{ V} = V_{CE}$$

5 b) ileri aktif

10 c)



$$\frac{V_o}{V_i} = - \frac{R_C // R_L}{r_e} = -109 \quad r_e = \frac{V_T}{I_C} = 1$$

$$5 d) \quad r_i = \beta(r_e) = 1,4 \text{ k}$$

$$r_i = R_B // r_i \approx r_i = \underline{1,4 \text{ k}}$$

3

$$I_D = \frac{\mu}{2} (V_{GS} - V_{th})^2$$

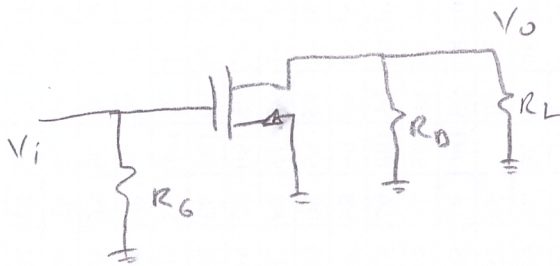
a)  
6

$$1 \text{ mA} = 100 \frac{200 \text{ cm}^2/\text{Vs} \cdot 10^{-7} \text{ F/cm}^2}{2} (-V_{GS} - (-0,7))^2$$

$$(V_{GS} + 0,7)^2 = 1 \quad -V_{GS} + 0,7 = -1$$
$$-V_{GS} = -1,7 \text{ V}$$
$$V_{GS} = 1,7 \text{ V}$$

b)

6



c)  
6

$$\frac{V_o}{V_i} = -g_m R_L // R_D = -4,8 \frac{\text{V}}{\text{V}}$$

$$g_m = \sqrt{2\mu I_D} = 0,002 \text{ S}$$
$$= 2 \text{ mS}$$

d)

7

$$V_{DS} > V_{GS} - V_T \quad N$$

↓

$$V_{DS} < V_{GS} - V_T \quad P$$

$$V_{DS} < V_{GS} - V_T$$

$$-7 \text{ V} + I_D \cdot R_D = -1,7 - (-0,7)$$

$$I_D \cdot R_D = 6 \text{ V}$$

$$R_D = 6 \text{ k}\Omega$$

4

$$I_{D2} = \frac{\beta}{2} (V_{GS2} - V_{TP})^2 (1 + \lambda_p V_{GS})$$

$$V_{GS2} = V_o - V_{DD}$$

a)  $100 \mu A = \frac{50 \mu A}{2 \frac{V}{V^2}} \cdot \left( \frac{V_o - V_{DD} + 0,5}{x} \right)^2 (1 + 0,56 \cdot \frac{V_{DD} - V_{DD}}{x})$

10

$$4 = (x + 0,5)^2 (1 + 0,56x)$$

$$x = -1,9 = V_o - V_{DD} \Rightarrow V_o = 3,1 \text{ V}$$

V.

$$I_{D1} = \frac{\beta}{2} (V_{GS} - V_{TN})^2 (1 + \lambda V_{GS})$$

$$100 \mu A = \frac{120 \mu A}{2 \frac{V}{V^2}} (V_{GS} - 0,5)^2 (1 + 0,32 \cdot 3,1)$$

$$V_{GS} = 1,4 \text{ V}$$

$$g_{m1} = \sqrt{2\beta_1 I_{D1}} = 0,15 \text{ mS}$$

$$g_{m2} = \sqrt{2\beta_2 I_{D2}} = 0,1 \text{ mS} = 10^{-4} \text{ S}$$

$$r_{o1} = \frac{1}{\lambda_1 I_{D1}} = 31,25 \text{ k}$$

$$r_{o2} = \frac{1}{\lambda_2 I_{D2}} = 17,86 \text{ k}$$

b) 10

$$r_o = r_{o1} // r_{o2} // \frac{1}{g_{m2}} = 5,3 \text{ k}$$

$\downarrow$   
 $10 \text{ k}$

c) 5

$$\frac{V_o}{V_i} = -g_{m1} \cdot r_o = -(5,3 \text{ k}) \cdot (0,15 \text{ mS}) = 0,8 \frac{\text{V}}{\text{V}}$$