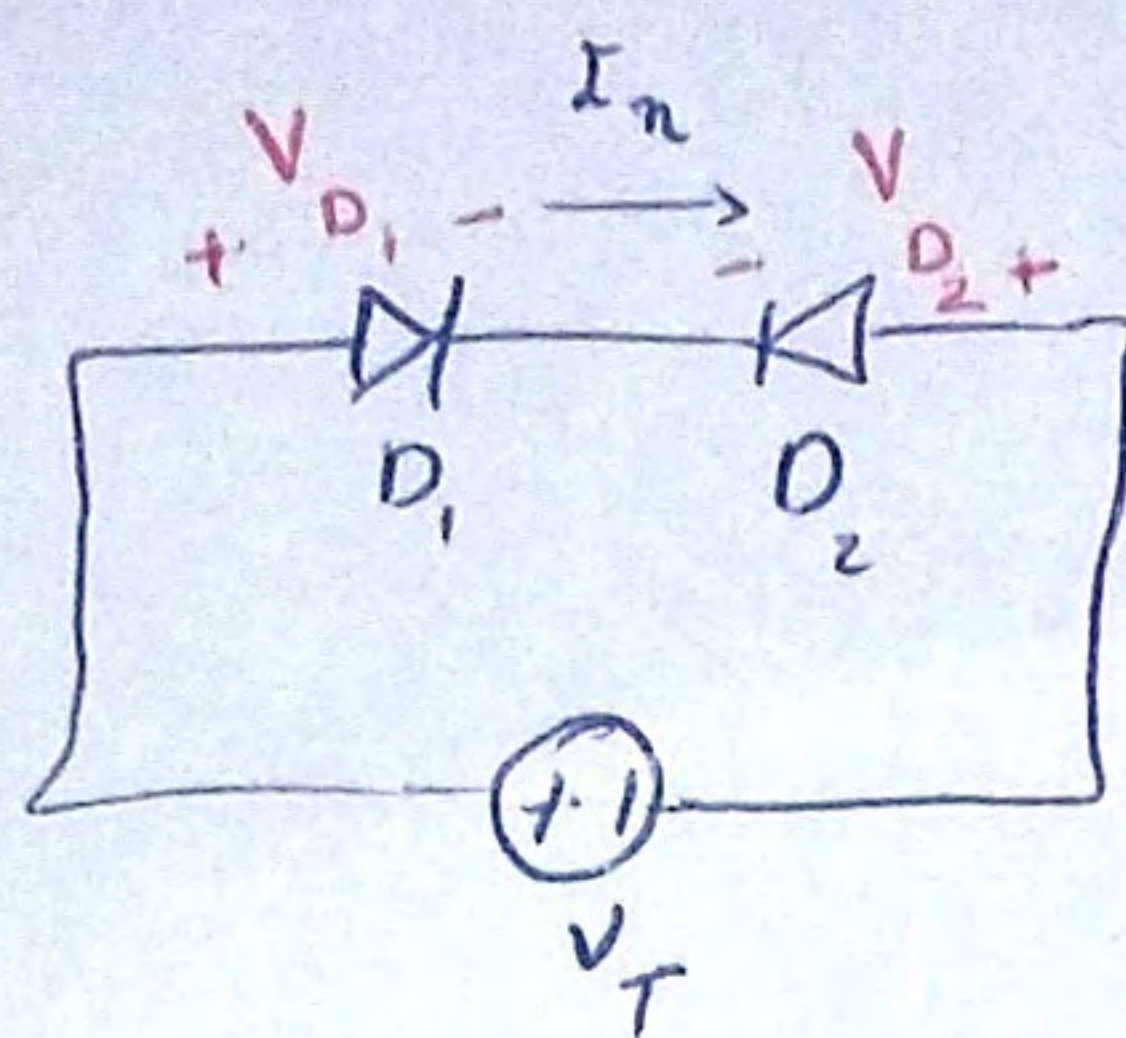




$$I_{S2} = 10 I_{S1}$$

$$\eta_2 = \eta_1 = 1$$

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جریان عبور از هر یک از دیودها برابر است با I_n و ولتاژ هر یک از دیودها برابر است با V_T

حل:

$$\left. \begin{array}{l} D_1: \text{دیود مستقیم} \\ D_2: \text{دیود معکوس} \end{array} \right\} \Rightarrow \boxed{I_n = I_{S2}} \quad (1)$$

اگر فرض کنیم که هر یک از دیودها دارای ولتاژ معکوس V_T باشد، در این صورت ولتاژ هر یک از دیودها برابر است با V_T و ولتاژ کل برابر است با $2V_T$

$$\boxed{I_n = I_{S1} = 0.1 I_{S2}} \quad (2)$$

محاسبه معادله بازنشانی ولتاژ دیودها:

$$V_{D1} - V_{D2} = V_T$$

$$I_D = I_S e^{V_D / \eta V_T} \quad \eta = 1 \Rightarrow \begin{cases} I_{D1} = I_{S1} e^{V_{D1} / V_T} \\ I_{D2} = I_{S2} e^{V_{D2} / V_T} \end{cases}$$

$$I_n = I_{D1} = + I_{D2} \Rightarrow I_{S1} e^{V_{D1} / V_T} = + I_{S2} e^{V_{D2} / V_T}$$

$$0.1 I_{S2} e^{V_{D1} / V_T} = + I_{S2} e^{V_{D2} / V_T}$$

$$e^{V_{D1} / V_T} = 10 e^{V_{D2} / V_T}$$

$$\ln e^{V_{D1} / V_T} = \ln (10) e^{V_{D2} / V_T} = \ln (10) + 2 e^{V_{D2} / V_T}$$

$$\Rightarrow \frac{V_{D1}}{V_T} = \ln 10 + \frac{V_{D2}}{V_T} \rightarrow \frac{V_{D1} - V_{D2}}{V_T} = \ln 10$$

$$\Rightarrow \frac{V_T}{V_T} \neq \ln 10 \Rightarrow \text{نتیجه!}$$

هیچ یک از سه حالت به جواب نرسیدند!

① $\begin{cases} V_{GS} = 0.5V \\ I_{D1} = 1\mu A \end{cases}$

② $\begin{cases} V_{GS} = 0.6V \\ I_{D2} = 2\mu A \end{cases}$

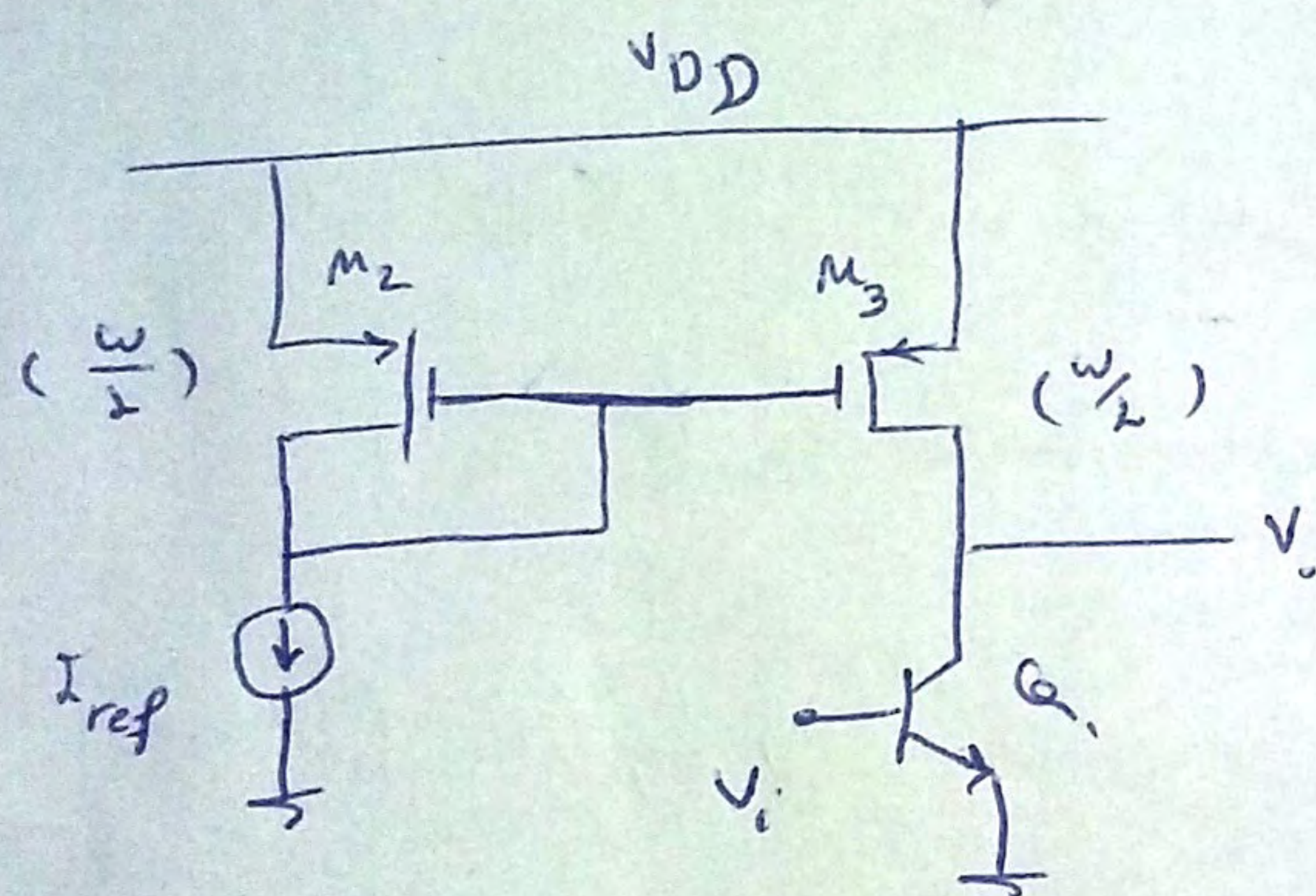
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$$I_D = k(V_{GS} - V_{th})^2, \quad k = \frac{1}{2} \mu_n C_{ox} \frac{W}{L}$$

$$\frac{I_1}{I_2} = \frac{1}{2} = \frac{k(0.5 - V_t)^2}{k(0.6 - V_t)^2} \Rightarrow (0.6 - V_t)^2 = 2(0.5 - V_t)^2$$

$$\rightarrow 0.6 - V_t = 2(0.5 - V_t) \rightarrow 0.6 - V_t = 1 - 2V_t \rightarrow \boxed{V_t = 0.2V}$$

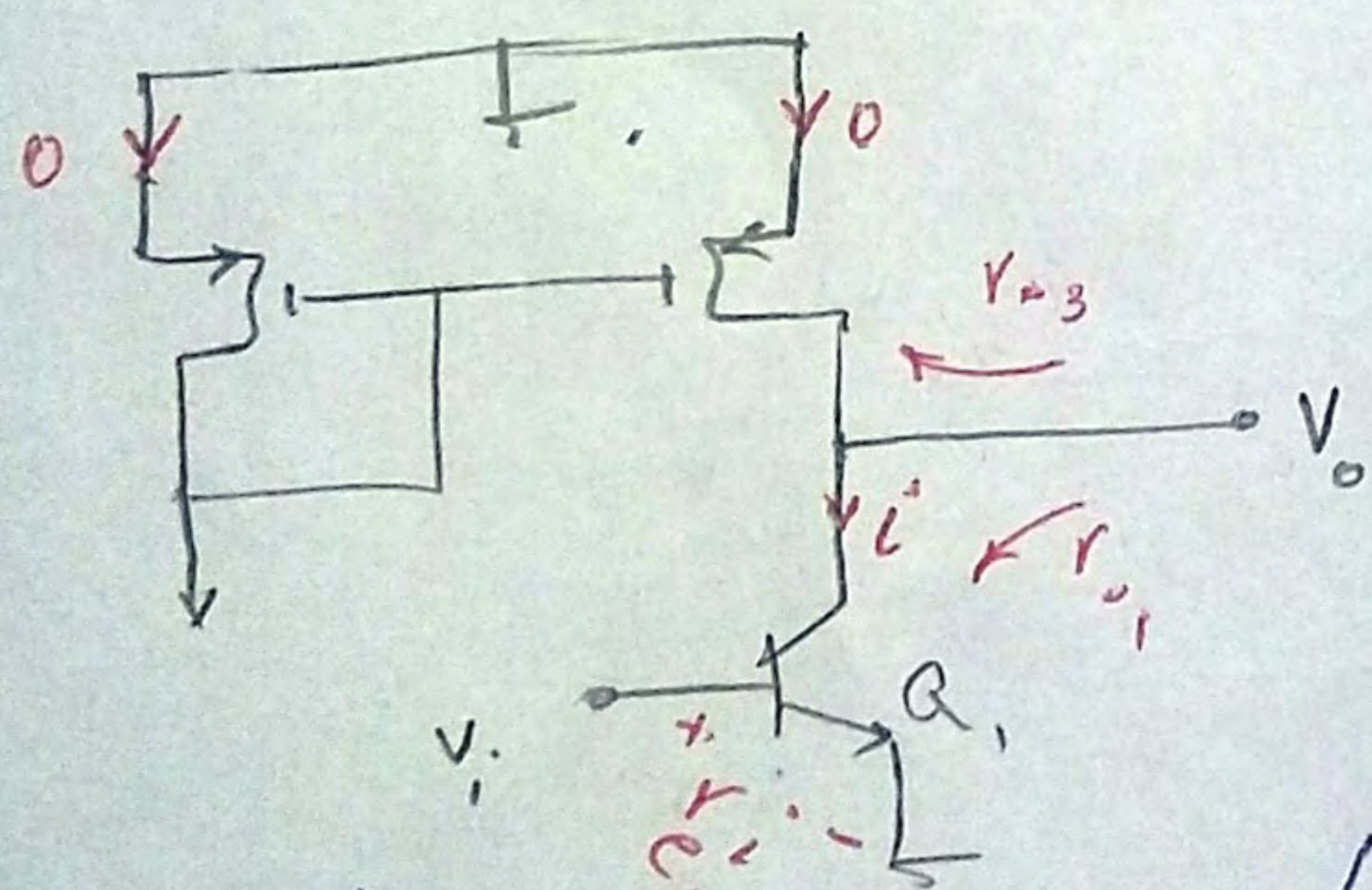
$$1 = k(0.5 - 0.2)^2 \rightarrow k = \frac{1}{0.09} = 1.11 \rightarrow \boxed{\mu_n C_{ox} \frac{W}{L} = 200 \frac{\mu A}{V^2}}$$



$M_2 = M_3$
 $V_{GS2} = V_{GS3}$ $\rightarrow I_1 = I_2 = I_3 = I_{ref}$

$Q_1: r_e = \frac{V_t}{I_{ref}}$

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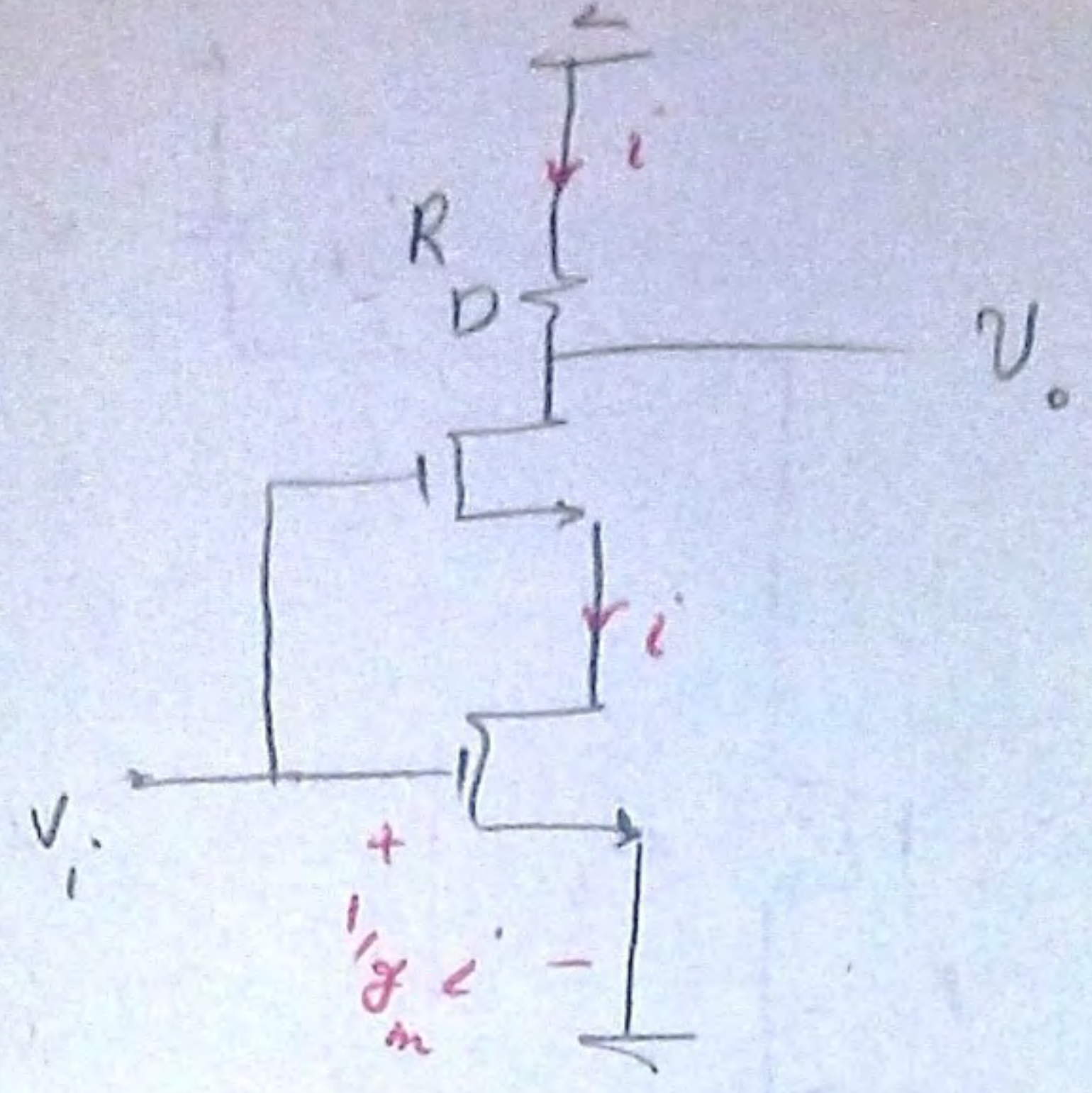
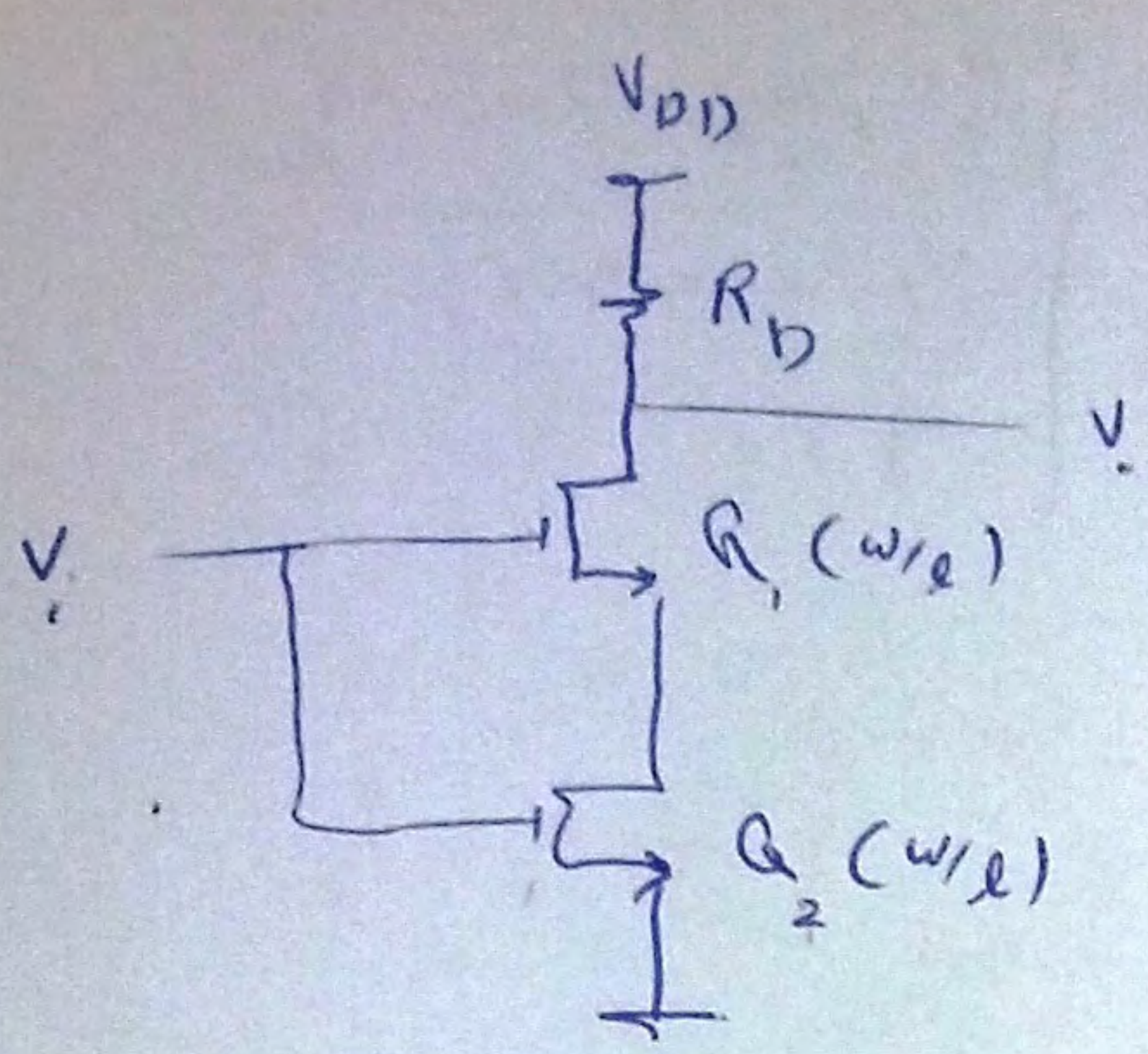
$$R_o = r_{o3} \parallel R_L$$

$$v_o = -i R_o$$

$$v_i = r_e i$$

$$\rightarrow A_v = -\frac{R_o}{r_e}$$

ماتریس به تابع A_v و R_o و r_e وابسته است. R_o با تغییر v_i می‌تواند تغییر کند. r_e هم تابع V_t و I_{ref} است و معین می‌شود. I_{ref} هم ثابت است پس بهر با تغییر v_i تغییر نمی‌کند.

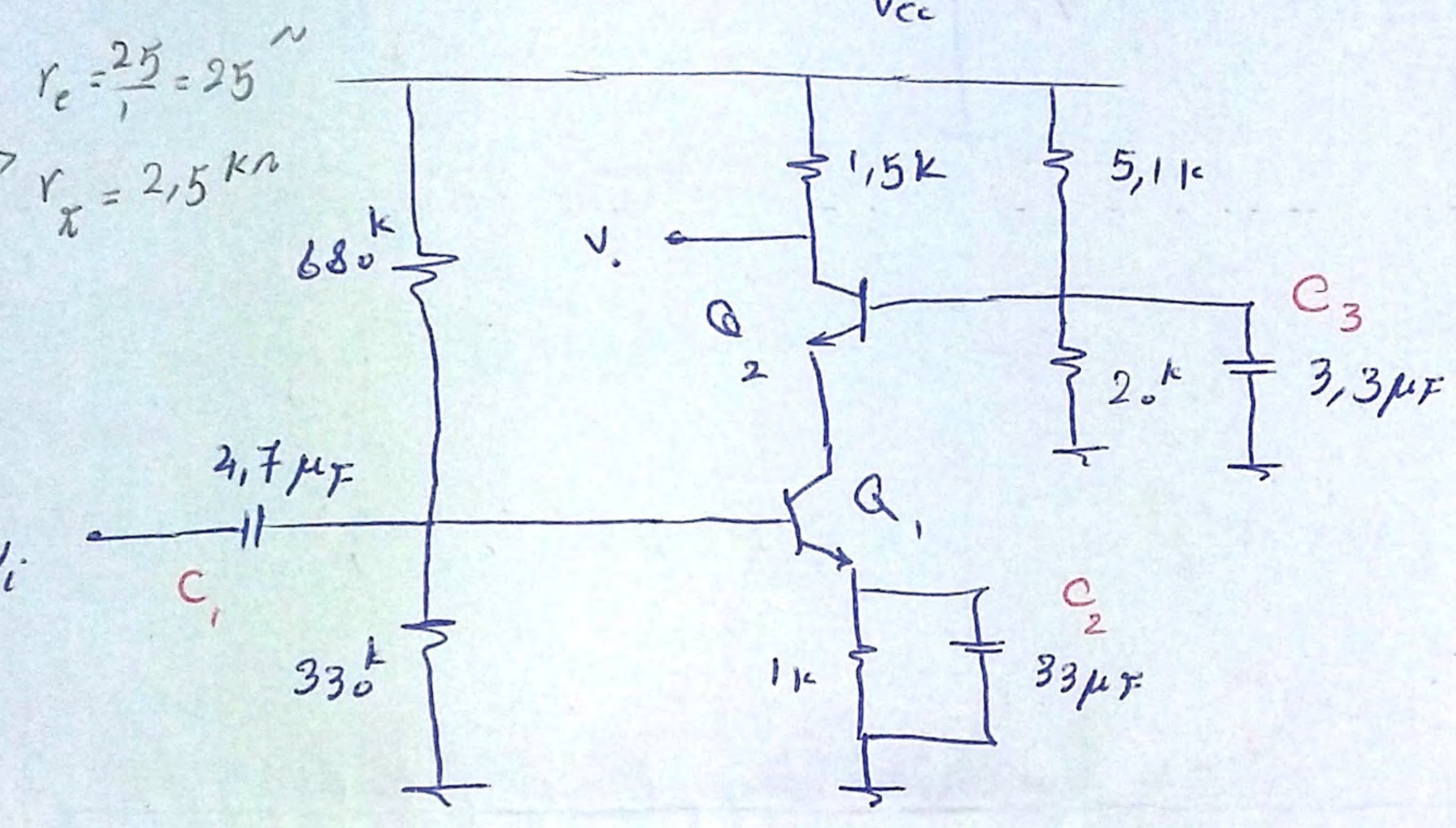


$$V_o = -R_D i$$

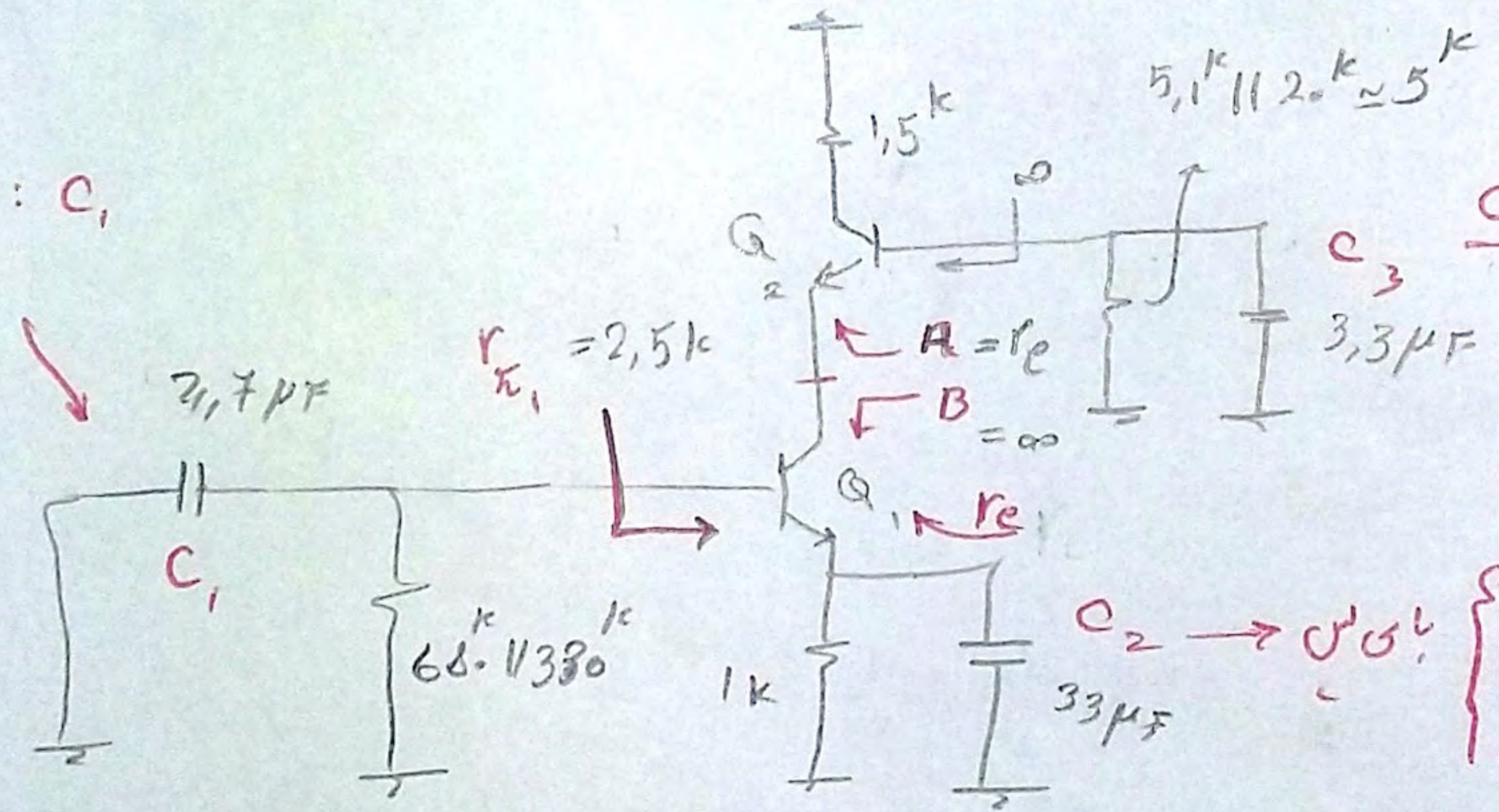
$$V_i = \frac{1}{g_m} i$$

$$A_v = \frac{V_o}{V_i} = \frac{-R_D i}{\frac{1}{g_m} i} = -g_m R_D$$

$I_C = 1 \text{ mA}$
 $\beta = 100$
 $V_T = 25 \text{ mV}$
 $V_A = \infty \rightarrow r_o = \infty$



$\omega_{Z_1} = 0$
 $\omega_{P_1} = \frac{1}{C_1 \times R_{\text{seen}_1}}$



$\omega_{Z_3} = \frac{1}{C_3 \times R_{\text{seen}_3}}$
 $\omega_{P_3} = \frac{1}{C_3 \times R_{\text{seen}_3}}$

$\omega_{Z_2} = \frac{1}{C_2 \times R_{\text{seen}_2}}$
 $\omega_{P_2} = \frac{1}{C_2 \times R_{\text{seen}_2}}$

$R_{\text{seen}_1} = 2.5 \text{ k} \parallel 33 \text{ k} \parallel 68 \text{ k} \approx 2.5 \text{ k}$

$R_{\text{seen}_2} = 1 \text{ k} \parallel r_e = r_e = 25 \Omega$

$R_{\text{seen}_3} = 5.1 \text{ k} \parallel 2 \text{ k} \parallel \infty = 5 \text{ k}$

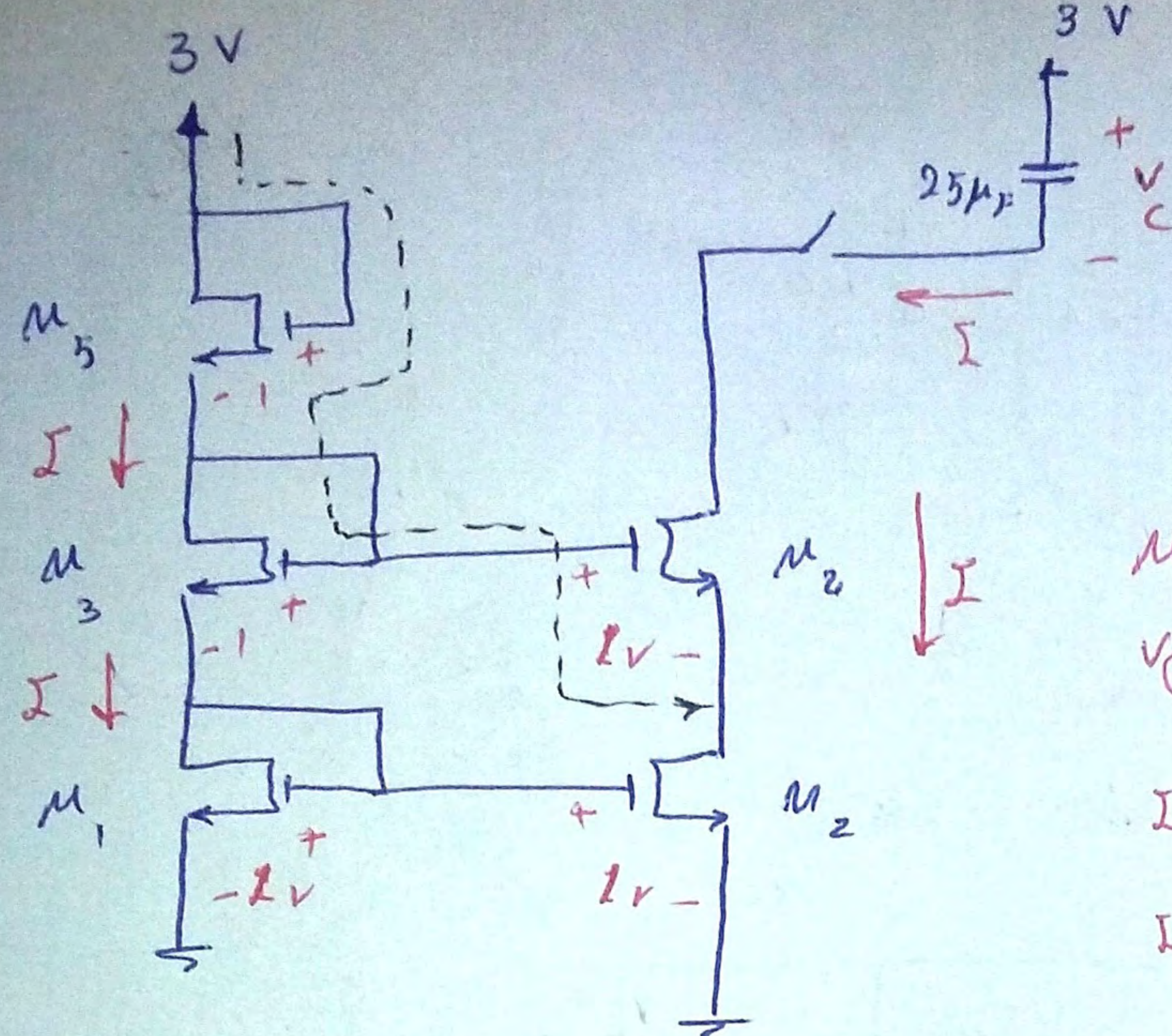
$\omega_{P_1} = \frac{1}{4.7 \times 10^{-6} \times 2.5 \times 10^3} = \omega_{Z_1} = 0$
 $\omega_{P_2} = \frac{1}{33 \times 10^{-6} \times 25} = \omega_{Z_2} = \frac{1}{33 \times 10^{-6} \times 10^{-3}}$

این صورتی ساده می شود و $\omega_{P_3} = \omega_{Z_3}$ می باشد

$\omega_{P_1} = \frac{10^5}{4.7 \times 25} \approx 85 \text{ rad/s}$
 $\omega_{P_2} = \frac{10^6}{33 \times 25} \approx 1200 \text{ rad/s}$
 $\omega_{Z_2} = \frac{10^3}{33} = 30$

نصفه ω_{P_2} و ω_{Z_2} را نادیده می گیریم و می توانیم بگوییم $\omega_{P_2} \gg \omega_{Z_2}$ و $\omega_{P_1} \gg \omega_{Z_1}$

$\omega_P = \omega_{P_1} + \omega_{P_2} = 1285 \text{ rad/s} \rightarrow f_u = 204 \text{ MHz}$



$$\begin{cases} \mu_n C_{ox} \frac{W}{L} = 200 \mu A/V^2 \\ V_t = 0.5 V \\ \lambda = 0 \end{cases}$$

$$\begin{cases} M_1 = M_2 \\ V_{GS1} = V_{GS2} \end{cases} \rightarrow I_1 = I_2$$

$$\begin{cases} I_1 = I_3 = I_5 \\ I_2 = I_4 \end{cases} \xrightarrow{I_1 = I_2} I_1 = I_2 = I_3 = I_4 = I_5 = I$$

$$\Rightarrow V_{GS1} = V_{GS5}$$

$$V_{GS1} + V_{GS3} + V_{GS5} = 3 \xrightarrow{V_1 = V_3 = V_5} V_{GS} = 1 V$$

$$I = k(V_{GS} - V_t)^2 \rightarrow I = \frac{1}{2} \times 200 \times (1 - 0.5)^2 = 100 \times 0.25 = 25 \mu A$$

میزان ولتاژ M_4 : $V_{DS4} > V_{GS4} - V_t \Rightarrow$

میزان ولتاژ:

$$V_{DS4} = 1 - 0.5 = 0.5 V$$

$$V_{D2} = 3 - V_c$$

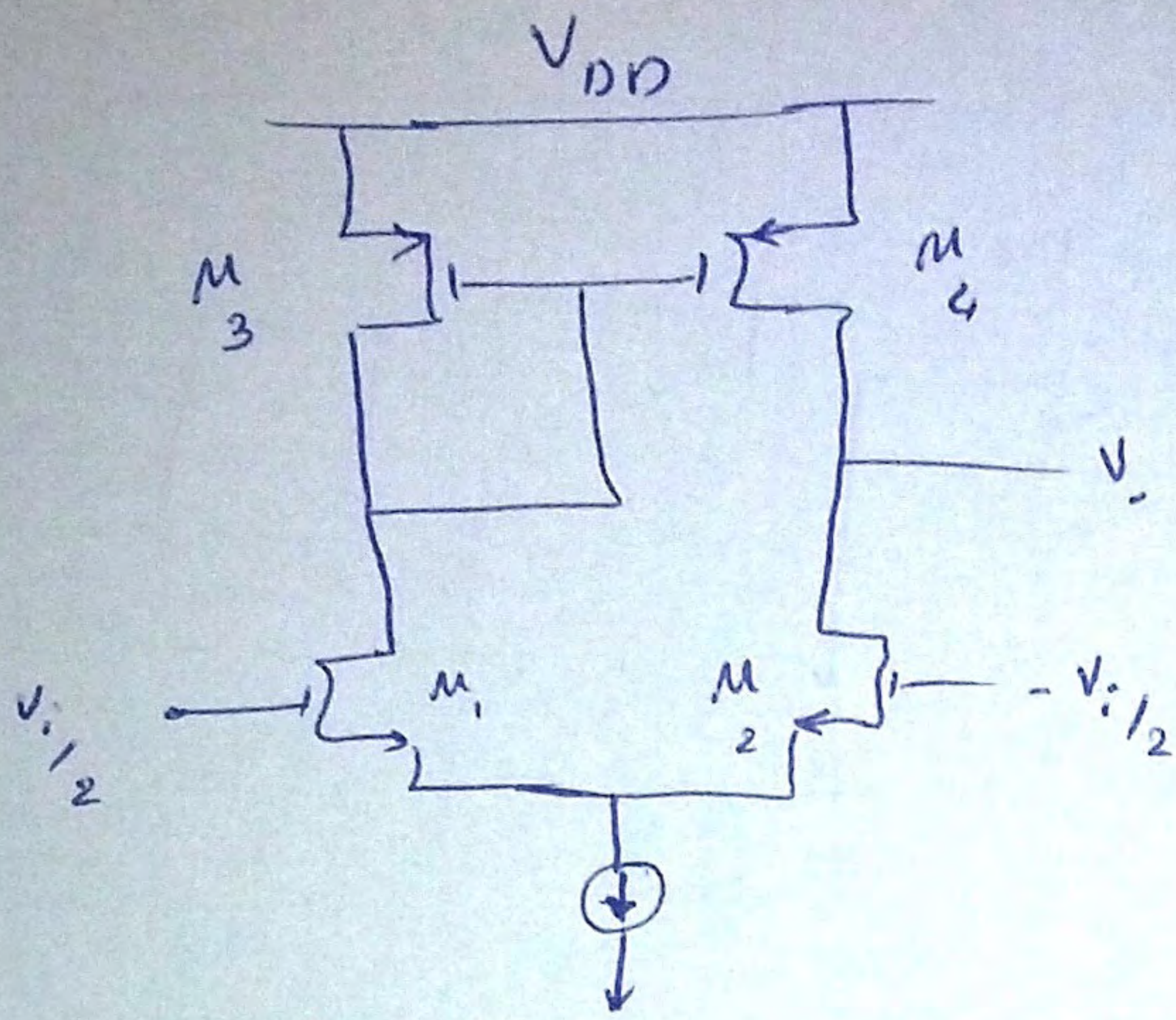
$$V_{S2} = 3 - 1 - 1 = 1 V$$

kV_2 می باشد

$$\Rightarrow 3 - V_c - 1 = 0.5 \rightarrow V_c = 1.5 V$$

$$V_c(t) = \frac{1}{C} \int I dt + V_c \rightarrow V_c(t) = \frac{1}{25 \mu F} \int 25 \mu A d\tau$$

$$\rightarrow 1.5 = \frac{25}{25} \tau \Big|_0^t \Rightarrow \boxed{t = 1.5 \text{ Sec}}$$



$$\mu_3 = \mu_4$$

$$r_{o1,2} = \infty$$

$$r_{o3,4} = 20k$$

$$g_{m1} = 1 \text{ mA/V}, \quad g_{m2} = 3 \text{ mA/V}$$

$$1/g_{m1} = 1k$$

$$1/g_{m2} = \frac{1}{3} k\Omega$$

$$R_o = r_{o4} || r_{o2} = 20k || \infty = 20k$$

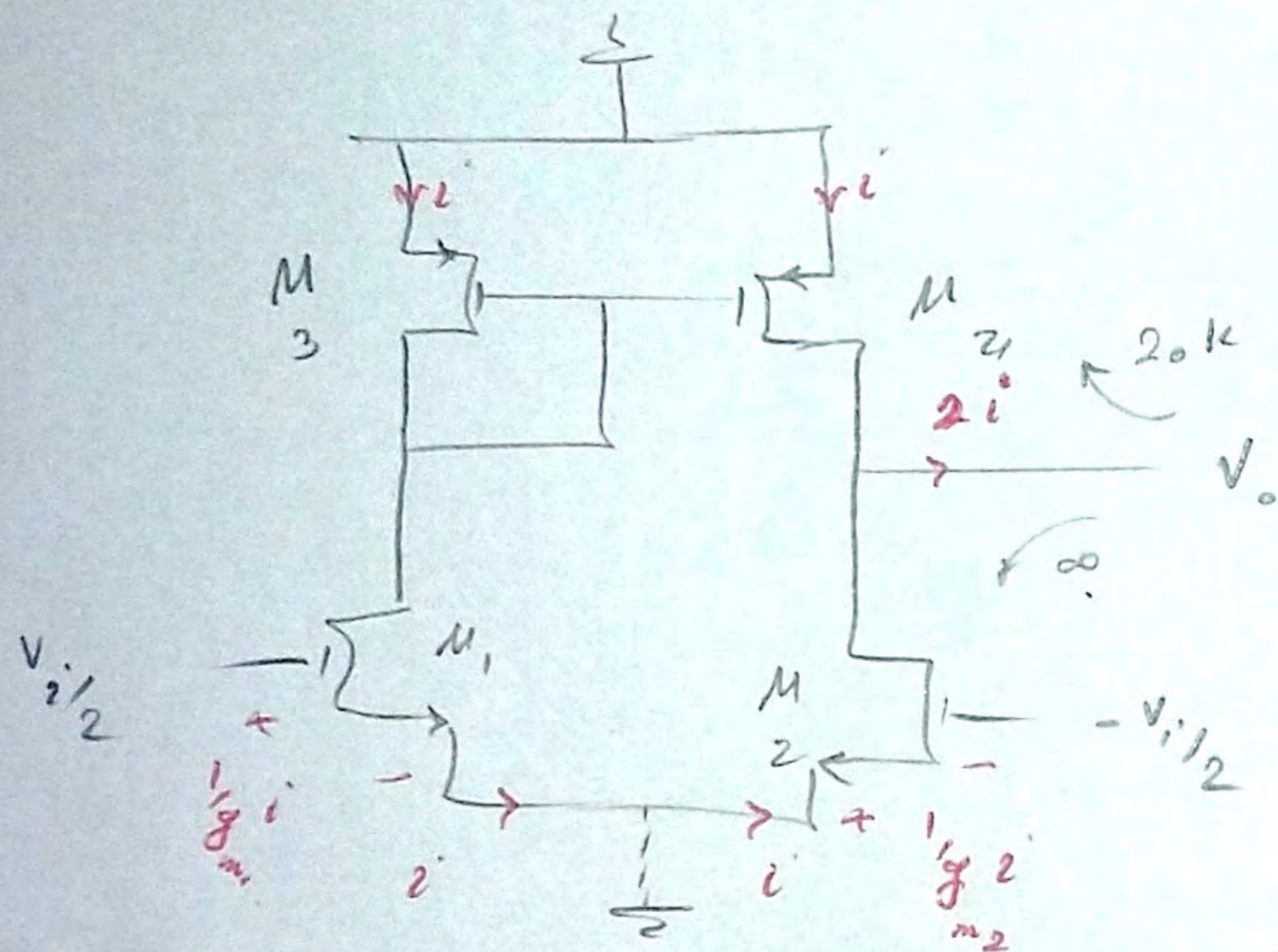
$$v_o = -2i R_o = -2 \times 20k \times i$$

$$v_o = -40k i$$

$$-\frac{v_i}{2} + 1k i + \frac{1}{3} k i - v_i/2 = 0$$

$$\rightarrow v_i = (1k + \frac{1}{3}k) i = \frac{4}{3} k i$$

$$\Rightarrow A_v = \frac{v_o}{v_i} = \frac{-40k}{\frac{4}{3}k} = -30$$



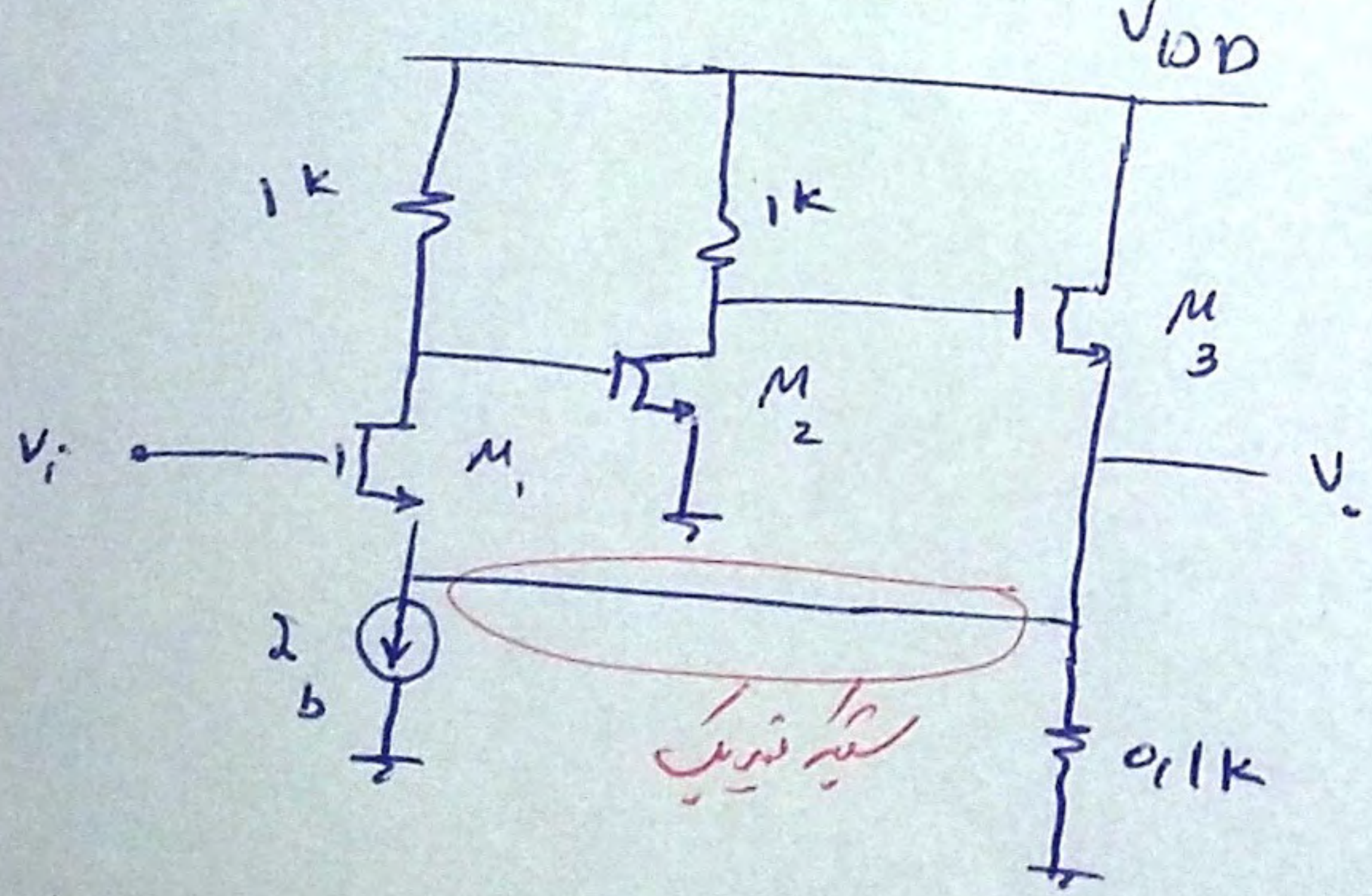
$$g_{m1} = g_{m3} = 1.0 \text{ mA/V}$$

$$V_A = \infty$$

$$r_{e1} = r_{e2} = r_{e3} = 0.1k\Omega$$

$$r_o = \infty$$

بیا کتون بزنیم



$$A = \frac{v_o}{v_i}, \quad f = \frac{v_f}{v_o}$$

$$f = \frac{v_f}{v_o} = 1$$

$$R = 0, \quad R' = \infty$$

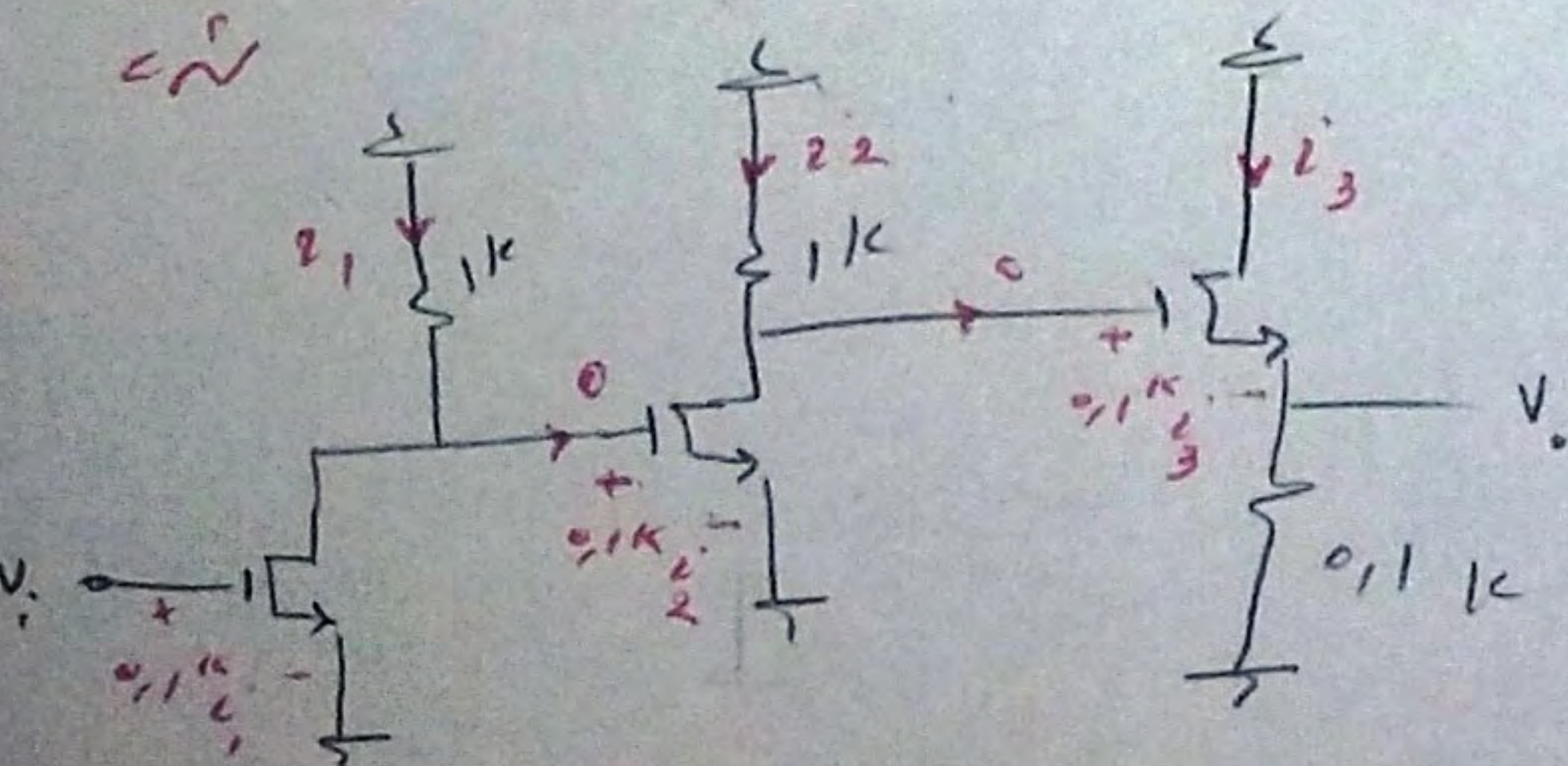
$$-1k i_2 = (0.1k + 0.1k) i_3 \rightarrow \frac{i_3}{i_2} = -5$$

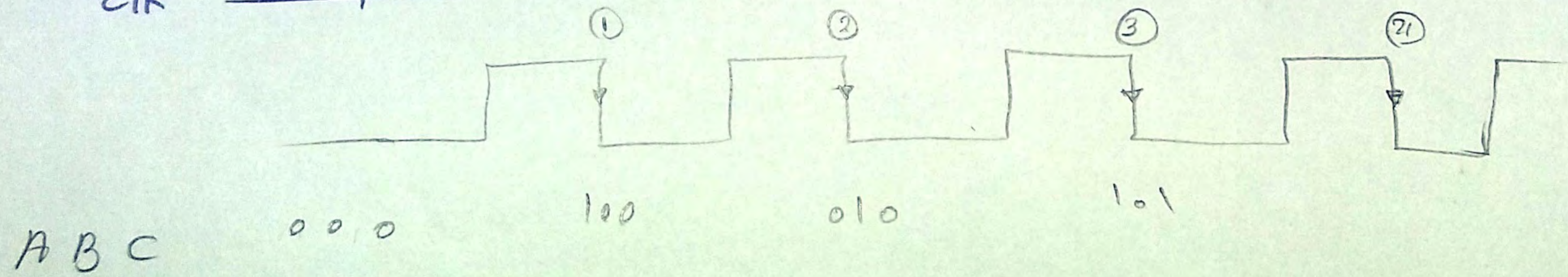
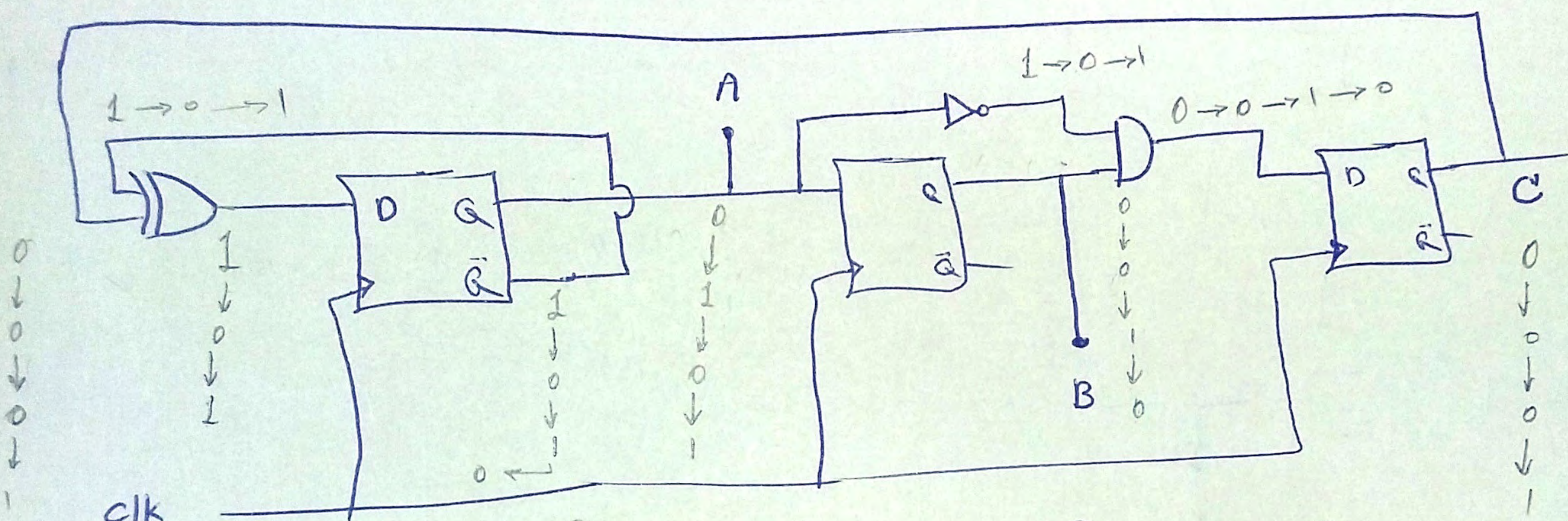
$$-1k i_1 = 0.1k i_2 \rightarrow \frac{i_2}{i_1} = -10$$

$$A = \frac{v_o}{v_i} = \frac{0.1k i_3}{0.1k i_1} = \frac{i_3}{i_1} = \frac{i_3}{i_2} \times \frac{i_2}{i_1} = +50$$

$$Af = (+50) \times (1) = +50$$

مارینگاری





A B C