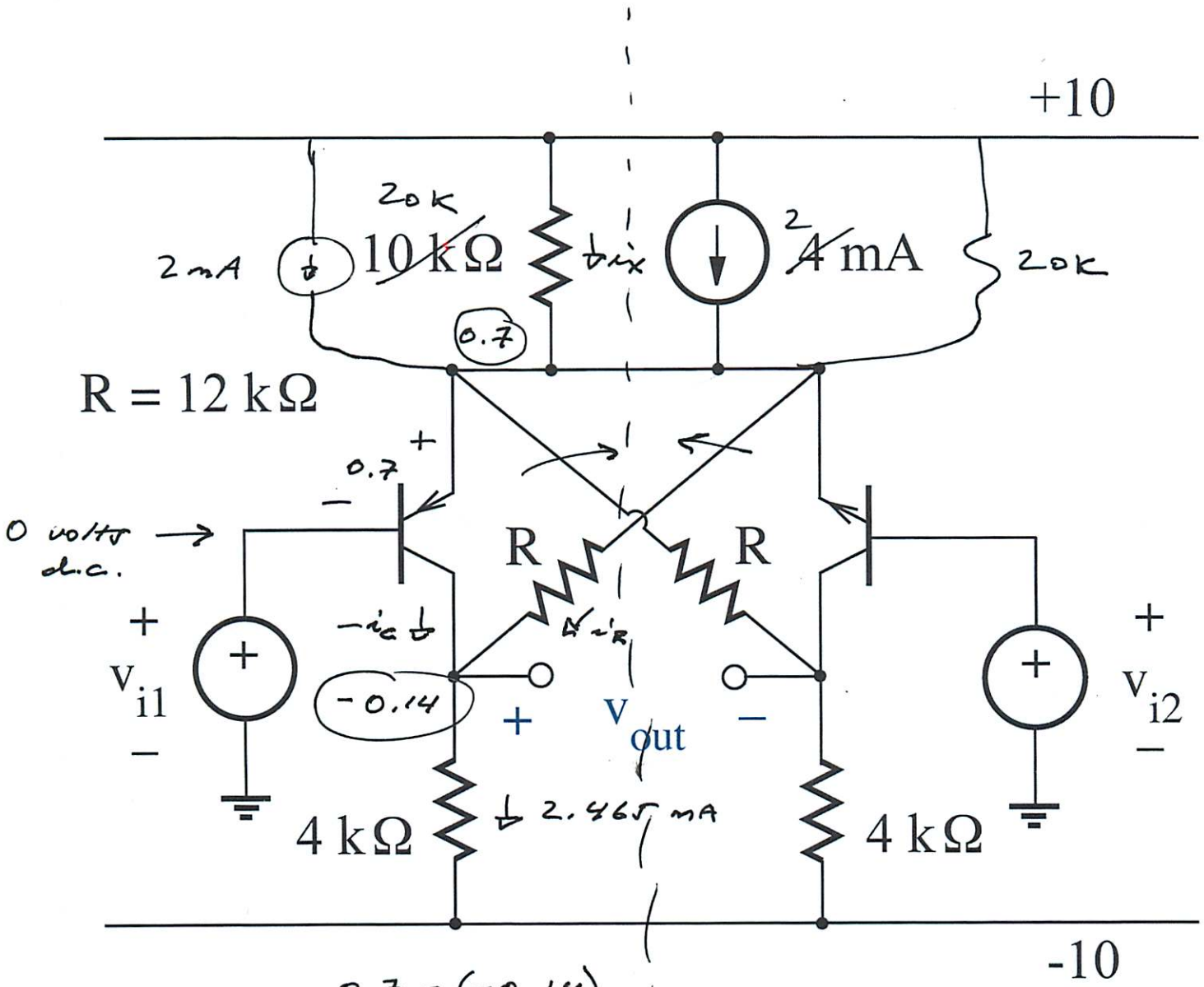
9.4

$\beta_0 = 100$

$i_x = \frac{10 - 0.7}{20K} = 0.465\ mA$

Q-point analysis:



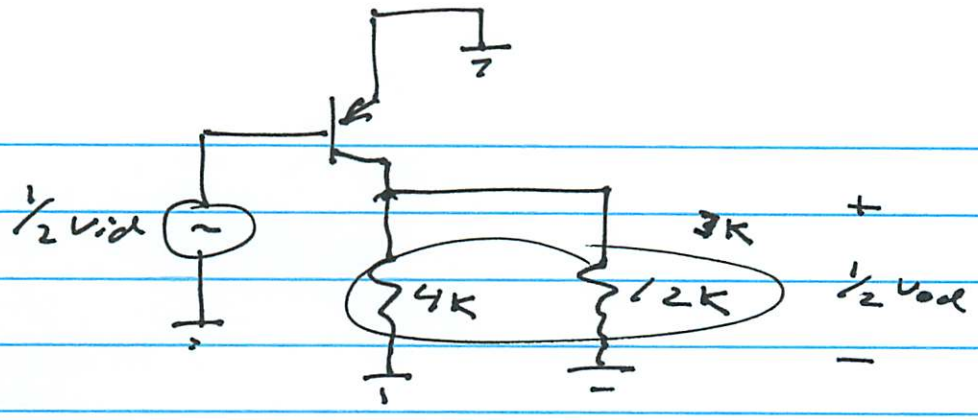
$i_R = \frac{0.7 - (-0.14)}{12K} = 0.07\ mA$

$\hookrightarrow -i_c = 2.465\ mA - 0.07\ mA$

$\approx 2.40\ mA$

$\rightarrow g_m = \frac{2.40\ mA}{25.9\ mV} = 92.7 \times 10^{-3}\ \mho$

A_{dd}
$\frac{1}{2}$ ckt.

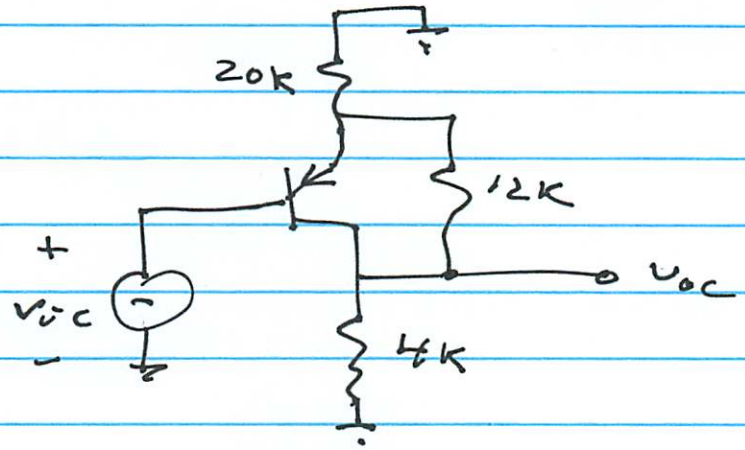


$$\frac{\frac{1}{2}v_{od}}{\frac{1}{2}v_{id}} = A_{dd} = -g_m(3K)$$

$$= -92.7\times10^{-3}\,\mathrm{U} \times 3\times10^{3}\,\Omega$$

$$= -278$$

A_{cc}
$\frac{1}{2}$ ckt.



$R_c' = 4K$

$R_e' = 20K$

Table 9.2

$r_o \rightarrow 12K$

$$\frac{v_{oc}}{v_{ic}} = A_{cc} = \frac{-g_m(R_c' \,//\, r_o)}{1 + g_m R_e' \left(1+\frac{1}{R_o}\right) / \left(1+\frac{R_c'}{r_o}\right)}$$

$$A_{cc} = \frac{-92.7\times10^{-3} \times 3\times10^{3}}{1 + 92.7\times10^{-3} \times 20\times10^{3} \times (1.01)/1.33}$$

$$= -0.197$$

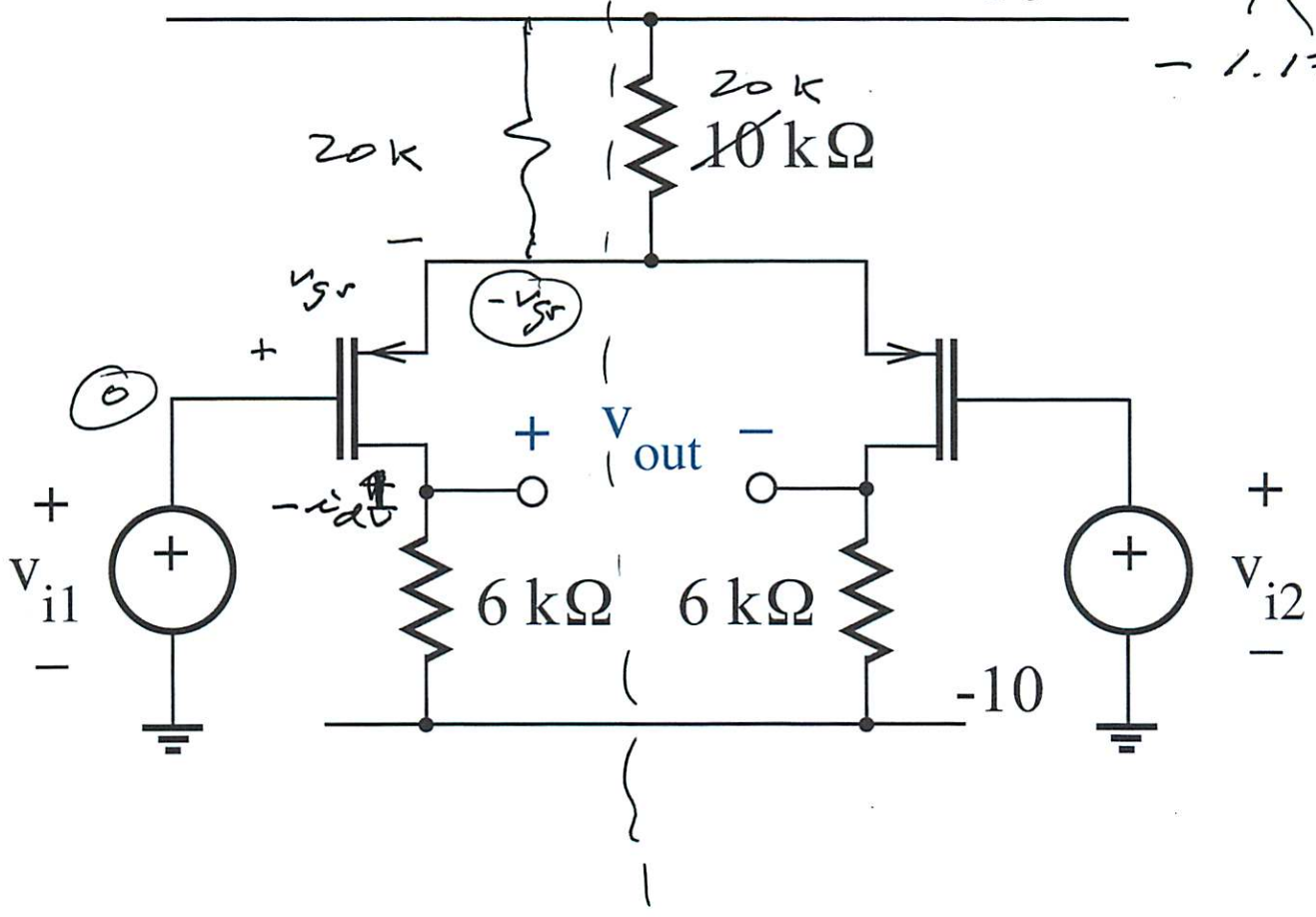
9.7 $K'\frac{W}{L} = 2\ mA/V^2$ $V_T = -0.5\ V$

Q-point analysis:

$$-i_d = \frac{10 + v_{GS}}{20} = \frac{1}{2}(v_{GS} + 0.5)^2$$

$$10 + v_{GS} = 20 v_{GS}^2 + 20 v_{GS} + 5$$

$$20 v_{GS}^2 + 19 v_{GS} - 5 = 0 \longrightarrow v_{GS} = \begin{matrix} 0.22 \\ -1.17\ V \end{matrix}$$

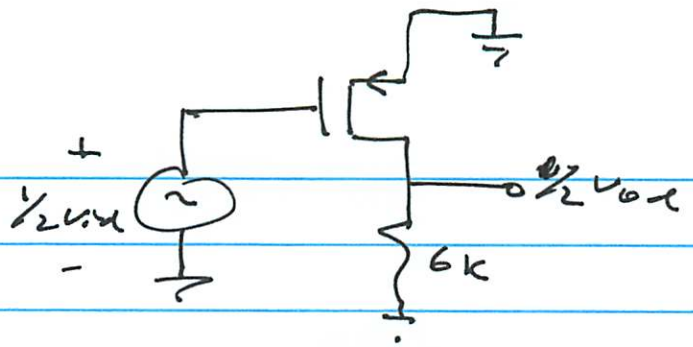


$$-i_{d1Q} = \frac{1}{2}(-1.17 + 0.5)^2 = 0.449\ mA$$

$$g_m = \sqrt{2 \times 2\ \frac{mA}{V^2} \times 0.449\ mA}$$

$$= 1.34 \times 10^{-3}\ \mho$$

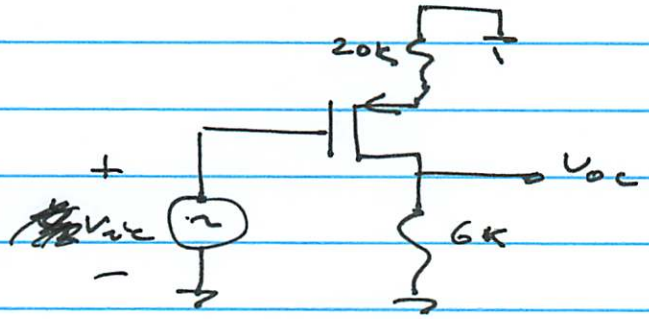
Add
½ ckt.



$$\frac{\frac{1}{2}V_{od}}{\frac{1}{2}V_{id}} = A_{dd} = -g_m(6k)$$

$$= -1.34\times10^{-2}\,\mho \times 6k\Omega = -8.04$$

Acc
½ ckt.



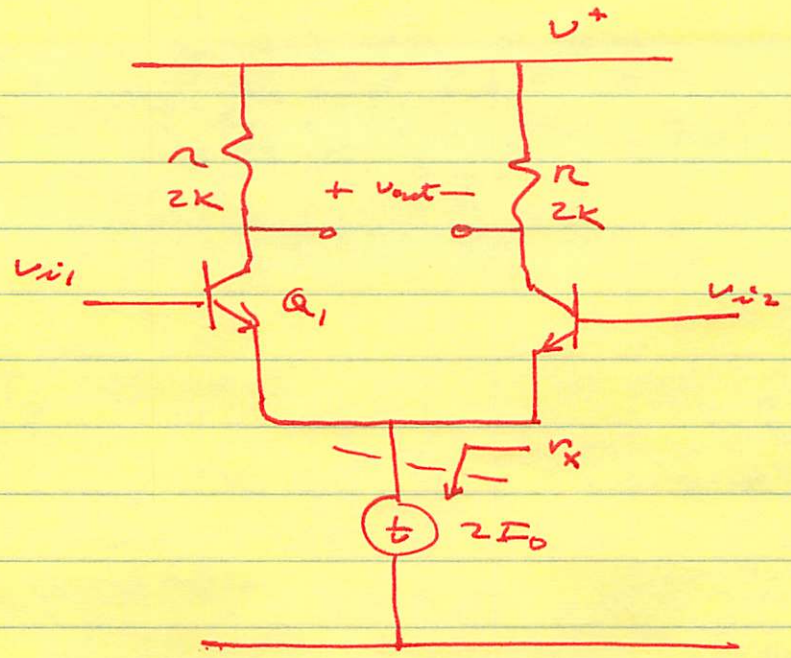
$$A_{cc} = \frac{V_{oc}}{V_{ic}} = \frac{-g_m(6k)}{1 + g_m(20k)}$$

$$= \frac{-8.04}{1 + 1.34\times10^{-2}\,\mho \times 20k\Omega}$$

$$= -0.289$$

$$CMRR = 20\log\left(\frac{-8.04}{-0.289}\right) = \underline{28.9\ dB}$$

9.17



$\beta = 100$

$$A_{dd} = -g_m R = -100 \rightarrow g_m = \frac{100}{2000} = 0.05\ \mathrm{V}$$

$$g_m = \frac{I_0}{kT/q} \rightarrow I_0 = 0.05 \times 0.0259$$
$$= 1.3\ \mathrm{mA}$$

$$A_{cc} = \frac{-g_m R}{1 + 2r_x g_m \left(1 + \frac{1}{\beta_0}\right)} = -0.001$$

↑ should be negative

$$1 + 2r_x g_m \left(1 + \frac{1}{\beta_0}\right) = \frac{-100}{-0.001} = 10^5$$

$$r_x \approx \frac{10^5}{2 \times 0.05 \times 1.01} = 990\ \mathrm{k}$$

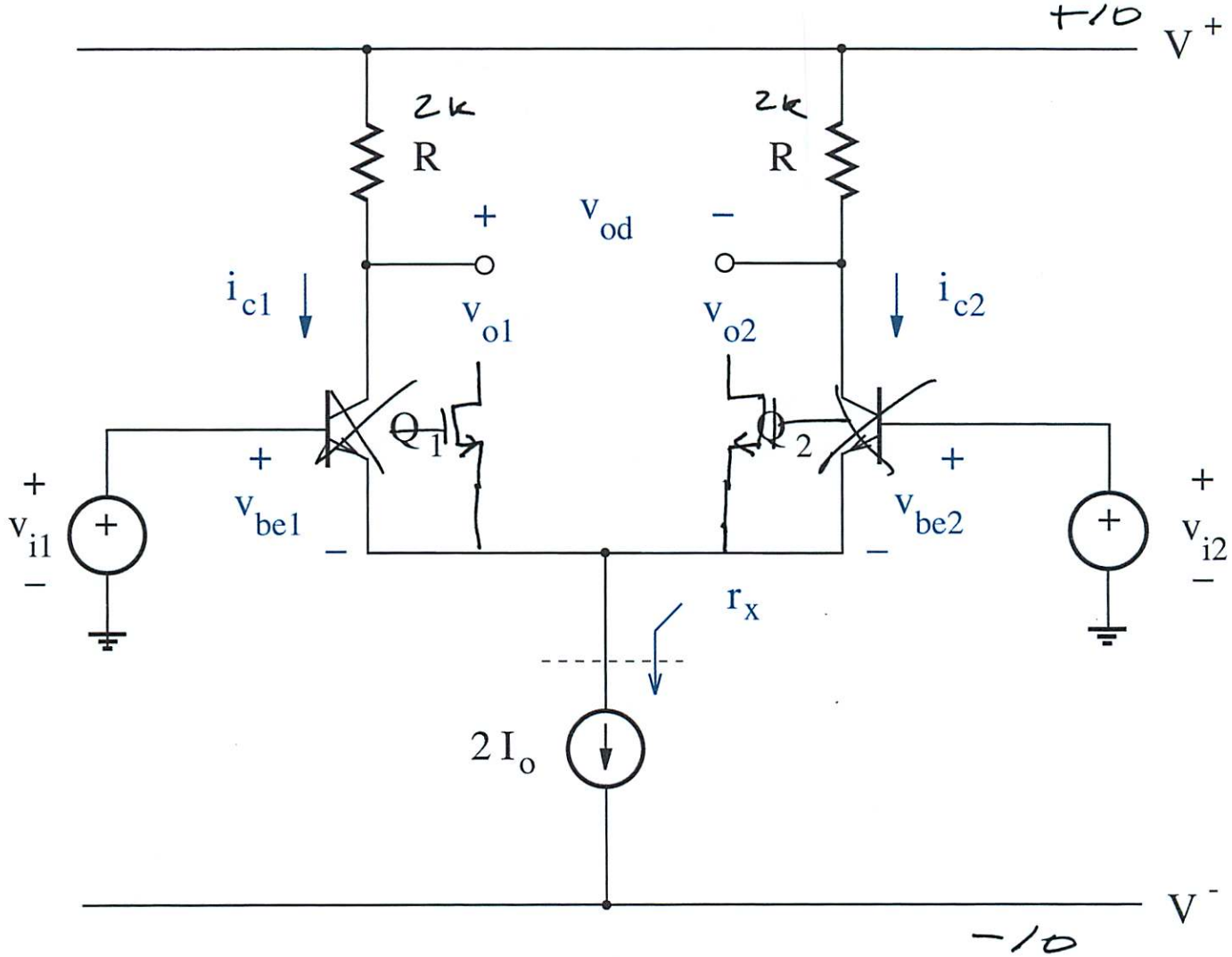
9.18 A_v before (9.17) $-g_m R$ = Add'l

$= -100$

$g_m = 0.05\ \mathrm{V}$

$= \sqrt{2 K' \frac{W}{L} i_{dlQ}}$

Let $i_{dlQ} = I_o = 1\ \mathrm{mA}$



$g_m = 1 \times 10^{-4} = 2 \times 50 \times 10^{-6} \left(\frac{W}{L}\right) \times 10^{-3}$

$\longrightarrow \frac{W}{L} = 5000$ $I_o = 10\ \mathrm{mA}$ probably better

$A_{cc} = \dfrac{-g_m R}{1 + 2 g_m r_x} \longrightarrow r_x \approx 1\ \mathrm{M\Omega}$

$K_n' = 50\ \mu\mathrm{A/V^2}$ $V_t = 0.5\ \mathrm{V}$