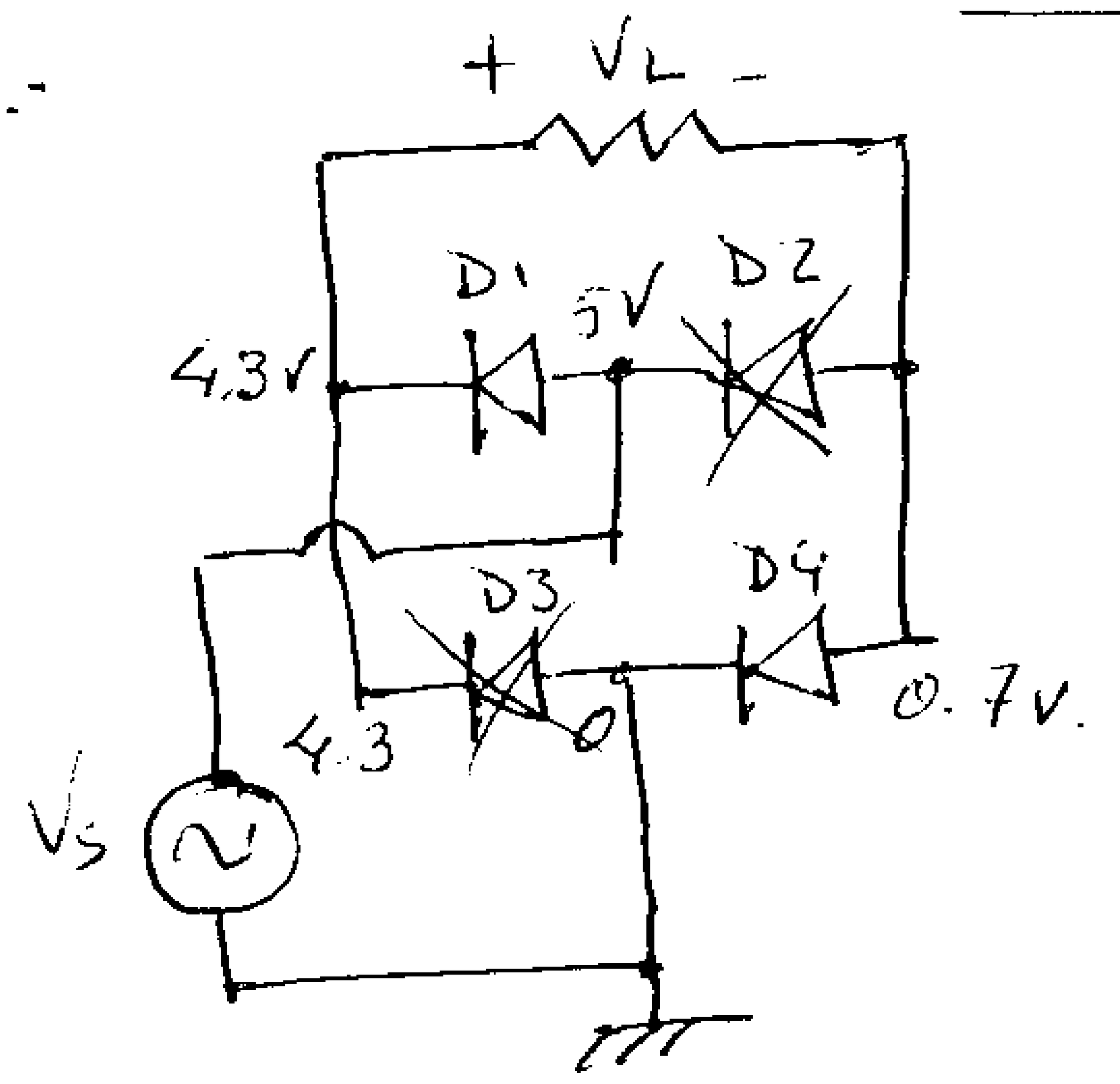
MIC 4120
EXAMEN INTRA 24 FEVR 2010
SOLUTIONS

Q1.-

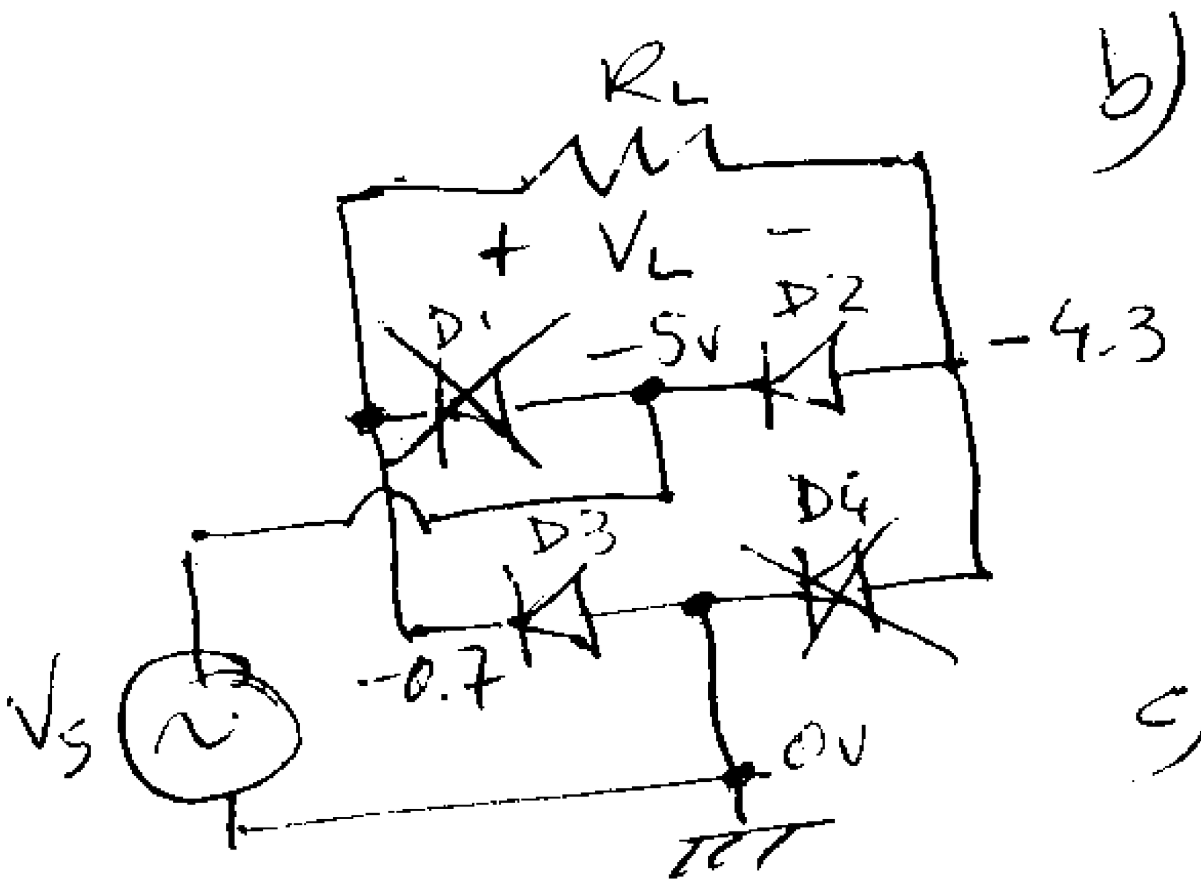


a) D1, D4 sont ON

D2, D3 OFF $V_S = 5$ V

$$I = \frac{4.3 - 0.7}{R_L} = \frac{3.6}{R_L}$$

$V_L = 3.6$ V.



b) $V_S = -5$ V

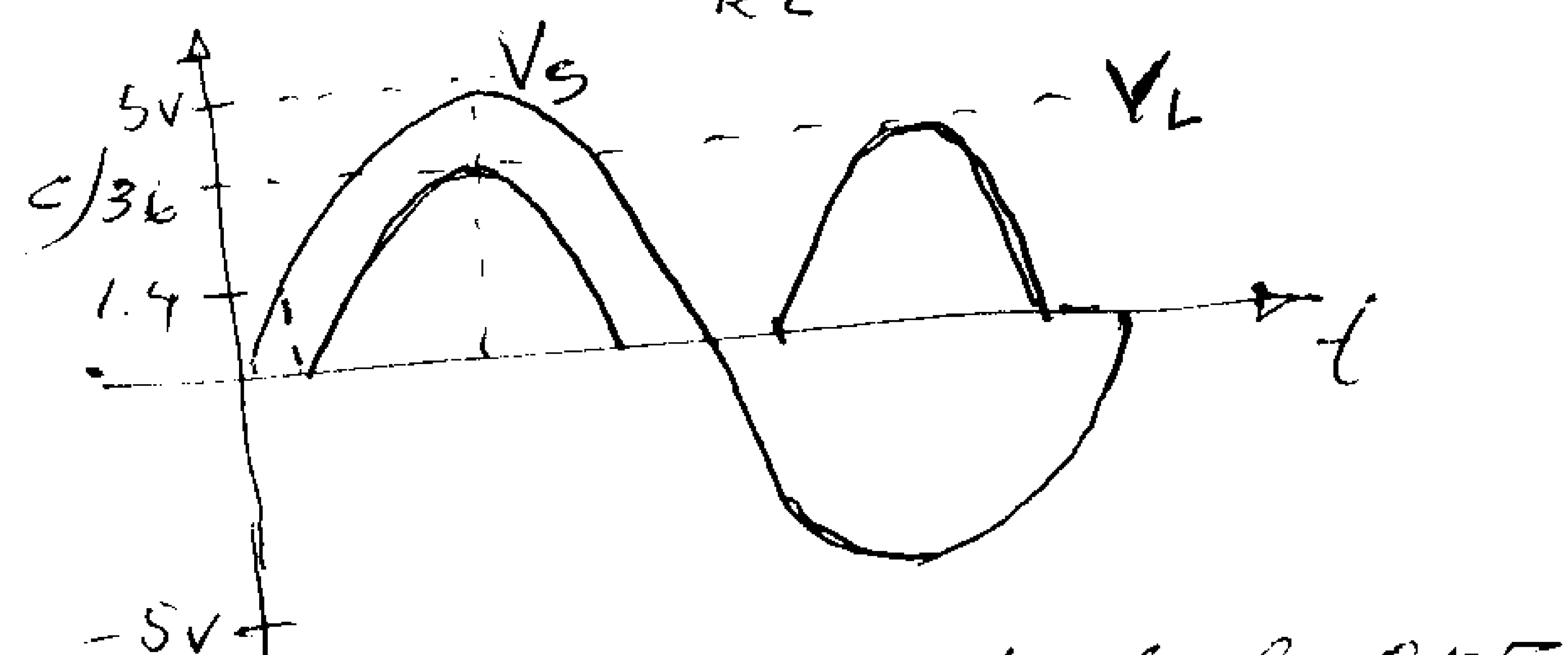
D2, D3 ON

D1, D4 OFF

$$I = \frac{-4.3 + 0.7}{R_L}$$

$V_L = 3.6$ V.

c)



d) Tension entre −10mV et +10mV. Toutes les diodes OFF.

$V_L = 0$ V.

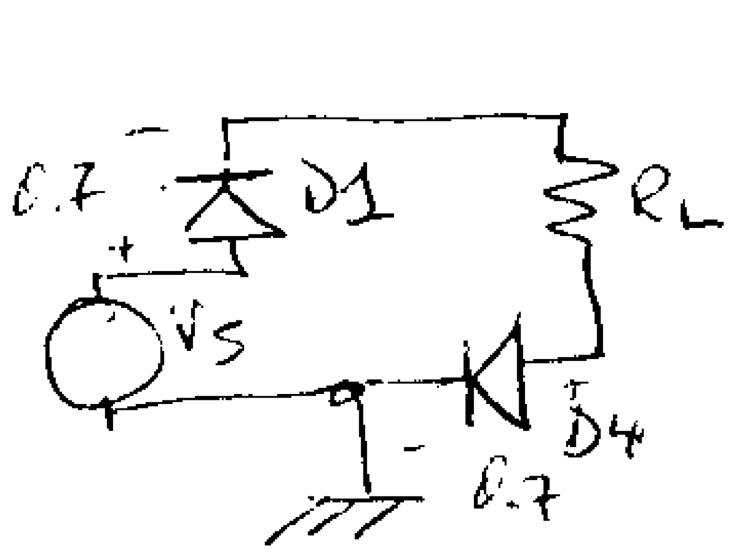
e) $V_S = 5V + 10\sin(\omega t)$ mV.

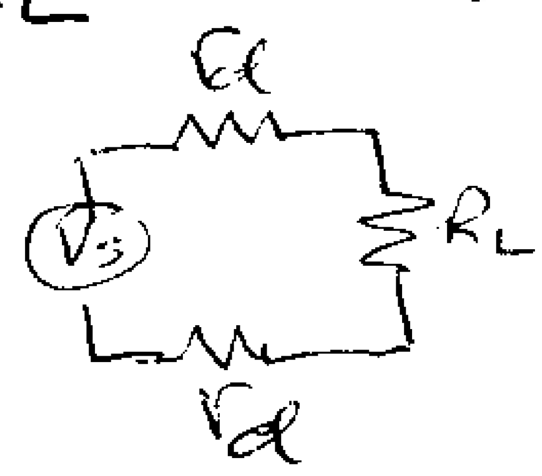
D1, D4 sont ON

D2, D3 sont OFF

$$I_L = \frac{5 - 1.4}{R_L} = \frac{3.6}{R_L}$$

$V_L = 3.6$ V. $\quad r_d = \frac{26\text{ mV}}{I_D} = \frac{26\text{ mV}}{3.6} R_L$





$$V_L = 3.6\text{ V} + \frac{R_L}{R_L + 2r_d} \cdot 10\sin(\omega t)\text{ mV}$$

$$= 3.6\text{ V} + 9.86\sin(\omega t)\text{ mV}$$

Q2 - a) $V_{B1} = V_{B2} = 1.8V$

$V_{C1} = V_{C2} = 1.8V$

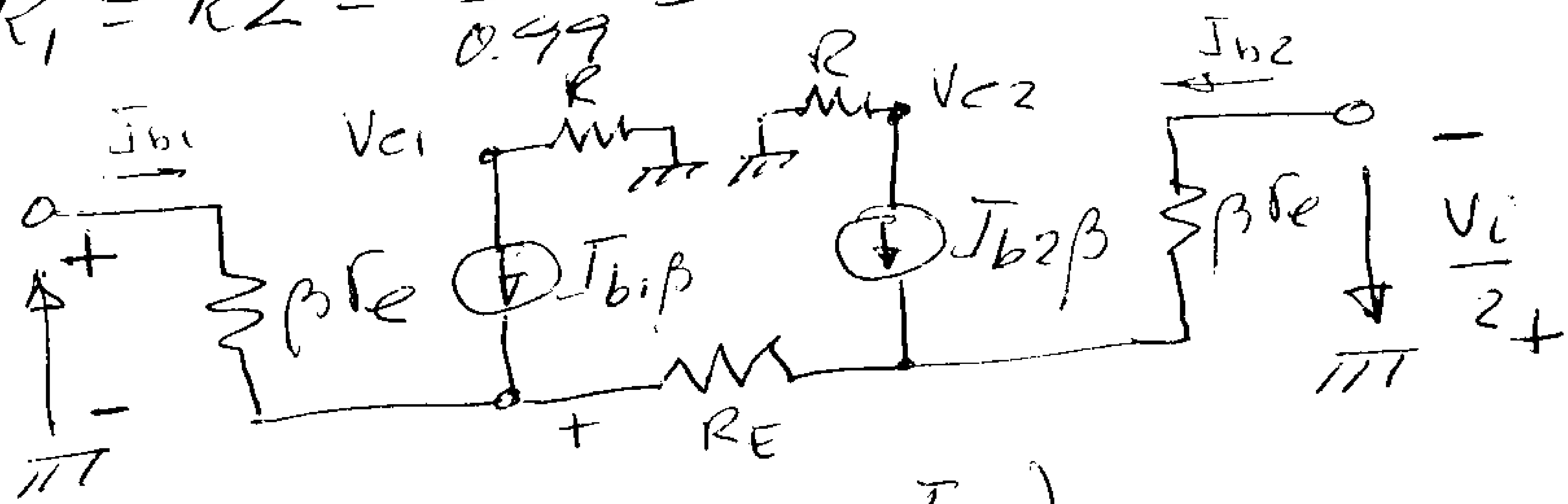
$$I_{C1} = I_{C2} = \frac{V_{CC} - V_{C1}}{R_1} = \frac{4-1.8}{R_1} = \frac{2.2}{R_1}$$

$$I_{E1} = I_{E2} = 1mA.$$

$$I_{C1} = \alpha I_{E1} = \frac{100}{101} \cdot 1mA = 0.99mA$$

$$R_1 = R_2 = \frac{2.2}{0.99} = 2.22k\Omega$$

b)



c) $V_{C1} - V_{C2} = \beta R (I_{b1} - I_{b2})$

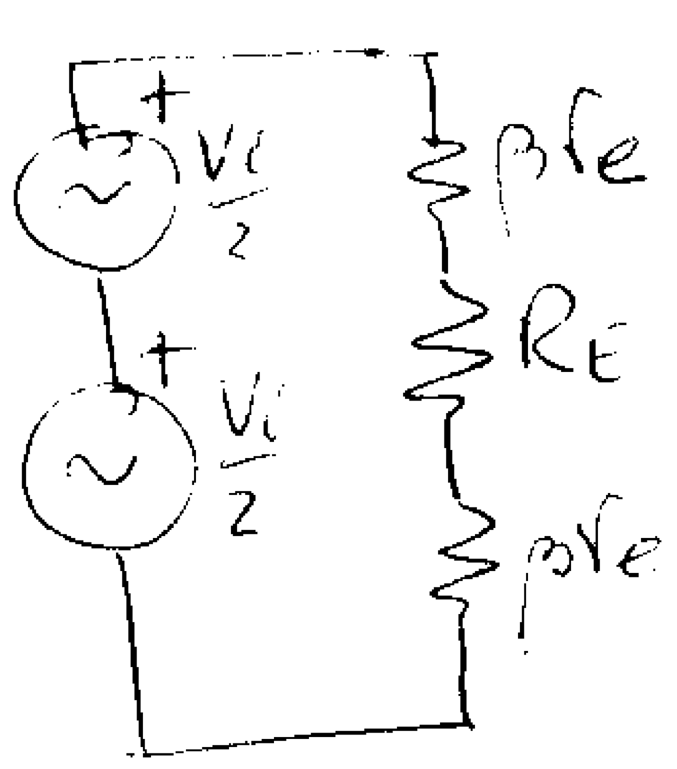
$$\frac{V_i}{2} = I_{b1}\,\beta \cdot r_e + V_{RE} - I_{b2} \cdot \beta r_e - \frac{V_i}{2}$$

$$V_i = \beta r_e (I_{b1} - I_{b2}) + V_{RE}$$

$$V_{RE} = R_E\left[(\beta+1) I_{b1} - (\beta+1) I_{b2}\right] = R_E(\beta+1)(I_{b1} - I_{b2})$$

$$\frac{V_{C1} - V_{C2}}{V_i} = \frac{\beta R (I_{b1} - I_{b2})}{\beta r_e (I_{b1} - I_{b2}) + R_E\left[(\beta+1)(I_{b1} - I_{b2})\right]} = \frac{\beta R}{\beta r_e + (\beta+1) \cdot R_E}$$

d)



$$R_{IN} = \frac{V_{in}}{i_b} = \frac{V_{in}}{\frac{i_e}{\beta+1}} = \frac{V_{in}(\beta+1)}{i_e}$$

$$i_e = \frac{V_{RE}}{R_E} = \frac{V_{in}}{R_E}\left[\frac{R_E}{2\beta r_e + R_E}\right] = \frac{V_{in}}{2\beta r_e + R_E}$$

$$R_{in} = \frac{V_{in}(\beta+1)}{V_{in}/(2\beta r_e + R_E)} = (\beta+1)(2\beta r_e + R_E)$$

Q3 — (Voir CHS. Ex 49-51) (cf Ex 5.16)

$$V_{B1} = \frac{3.3K}{3.3K + 6.4K + 8K} \cdot 20 = 3.72\ V.$$

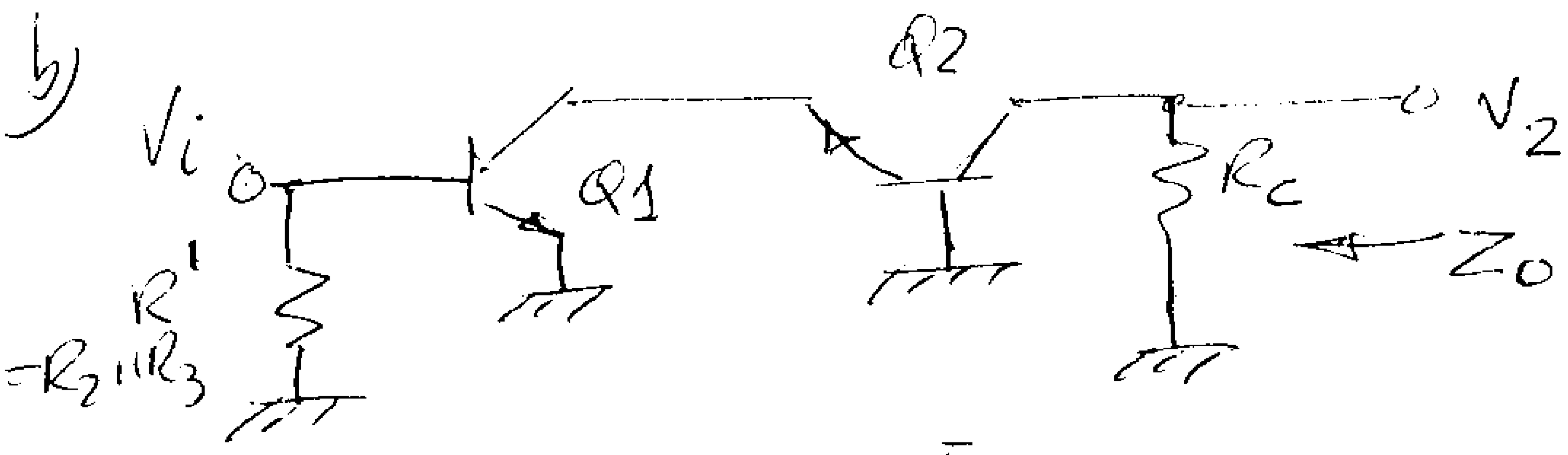
$$V_{B2} = \frac{6.4K + 3.3K}{3.3K + 6.4K + 8K} \cdot 20 = 10.96\ V.$$

$$V_{E1} = V_{B1} - 0.7 = 3.72 - 0.7 = 3.02\ V.$$

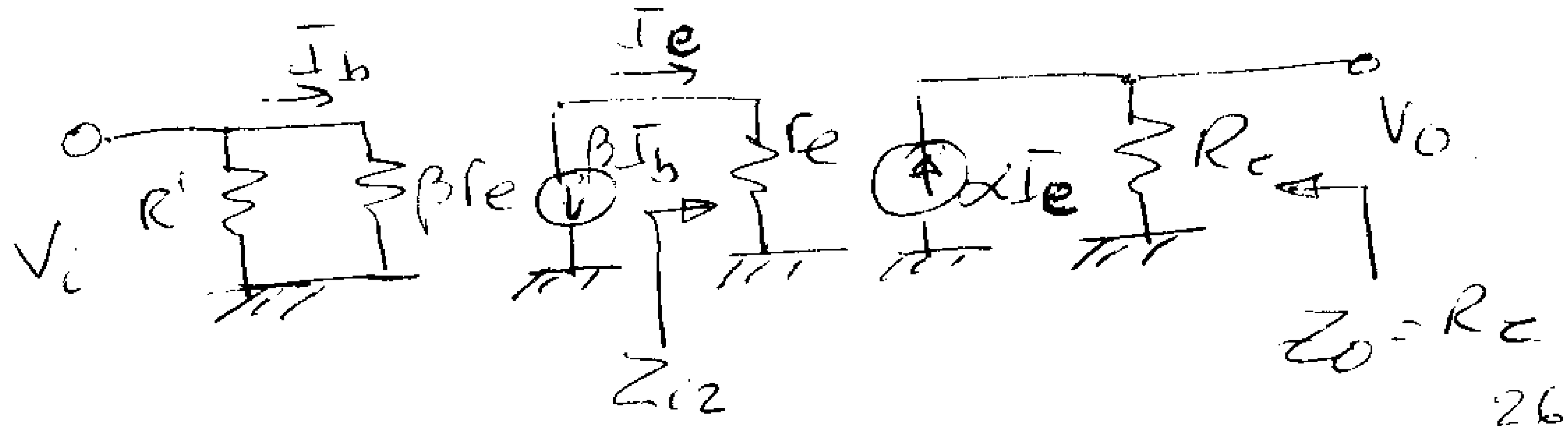
$$I_{C1} \simeq I_{E1} = \frac{V_{E1}}{R_E} = \frac{3.02}{1K} = 3\,mA = I_{E2} \simeq I_{C2}$$

$$V_{C2} = V_{CC} - I_C R_C = 20 - (3 \cdot 2) = 14\ V.$$

b)



$$\boxed{Z_o = R_C}$$



$$r_e = \frac{26}{3} = 8.67\ \Omega$$

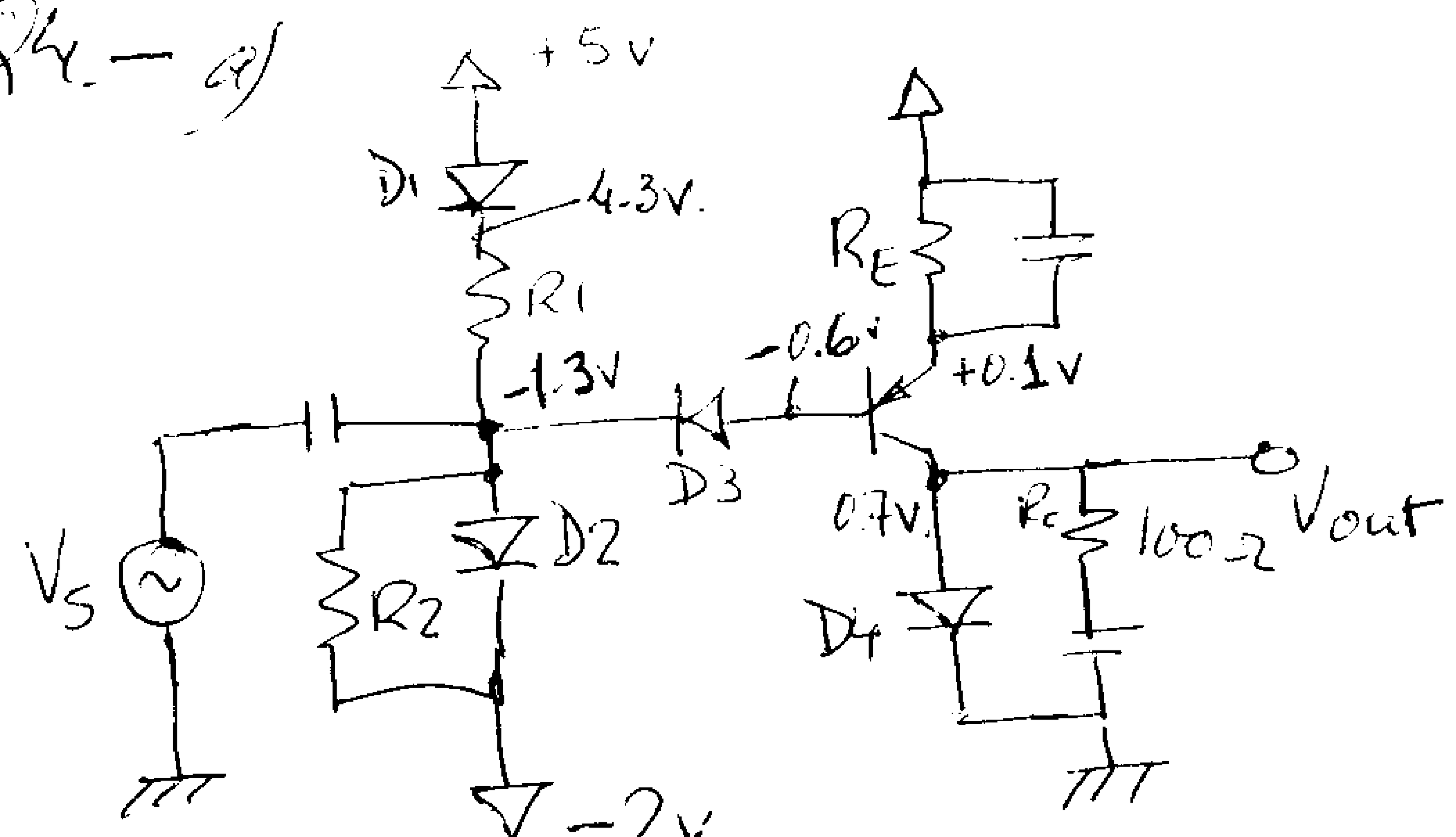
$$V_o = \alpha I_e \cdot R_C$$

$$I_E = -\beta I_b = -\beta \frac{V_i}{\beta r_e} = -\frac{V_i}{r_e}$$

$$V_o = \alpha \cdot \left(-\frac{V_i}{r_e}\right) R_C$$

$$\boxed{\frac{V_o}{V_i} = -\alpha \frac{R_C}{r_e}} \simeq -\frac{R_C}{r_e} = -232$$

Q4. — a)



on suppose que toutes les diodes sont ON

$I_E = \frac{5-0.1}{980} = 5mA \qquad I_{D4} = \alpha I_E = 4.9 mA$

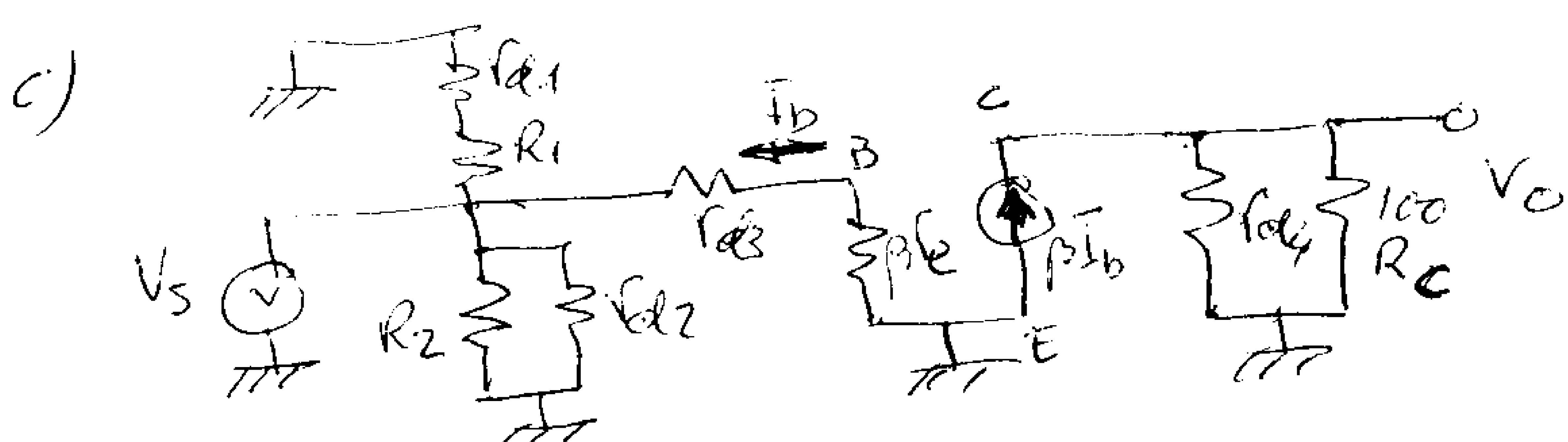
$I_{D3} = \frac{I_C}{\beta+1} = 0.1 mA.$

$J_{D1} = \frac{4.3-(-1.3)}{11.2K} = 0.5mA. \qquad I(R2) = \frac{0.7}{3.5K} = 0.2 mA$

$I_{D2} = I_{D3} + I_{D1} - I(R_2) = 0.4 mA.$

b) $\frac{0.7}{R_2} \leq 0.6 mA \qquad R_2 \geq 1,167 K\Omega$

c)



$r_e = \frac{26}{I_E} = \frac{26}{I_E} = \frac{26}{5.0} = 5.2\Omega$

$V_o = \beta I_b (r_{d4} \| R_c) \qquad V_s = -I_b(r_{d3} + \beta r_e)$

$r_{d4} = \frac{26}{4.9} = 5.3\Omega$

par substitution

$\frac{V_o}{V_s} = -\frac{\beta(r_{d4} \| R_c)}{r_{d3} + \beta r_e} = -\frac{50 \cdot 50}{520} = -4.8$

$r_{d3} = \frac{26}{0.1} = 260\Omega$

Q5.- a) $5V = V_{GS} + I_D \cdot 0.7K$ $\quad V_G = \frac{20 \cdot 30}{120} = 5V$

$I_D\Big|_{V_{GS}=0} = \frac{5}{0.7K} = 7.14mA = \overline{7.2}\ mA$

$V_{GS}\Big|_{I_D=0} = 5V = \overline{0.83}\ V.$

$I_{DQ} = 1.1 \cdot 6 = 6.6 mA$

$V_{GSQ} = 0.1 \cdot 6 = 0.6 V.$

b) $\left.\begin{array}{l} I_{DQ} = I_{DSS}\left(1 - \frac{V_{GSQ}}{V_P}\right)^2 \\ 5 = V_{GS} + I_{DQ} \cdot 0.7K \end{array}\right\} \begin{array}{l} I_{DQ} = 6.7\ mA \\ V_{GSQ} = 0.31 V \end{array}$

c) $I_E = 6.7 mA$ $\quad I_B = \frac{I_E}{\beta+1} = \frac{6.7}{161} = \underline{\underline{41.6 \mu A}}$

$V_B = 20 - 330 \cdot 41.6\ 10^{-3} = 6.3 V.$

$V_E = 5.6 V.$ $\quad V_C = 20 - 1.1 \cdot 6.7 = 12.6 V$

$V_{CE} = V_C - V_E = \underline{\underline{7 V.}}$

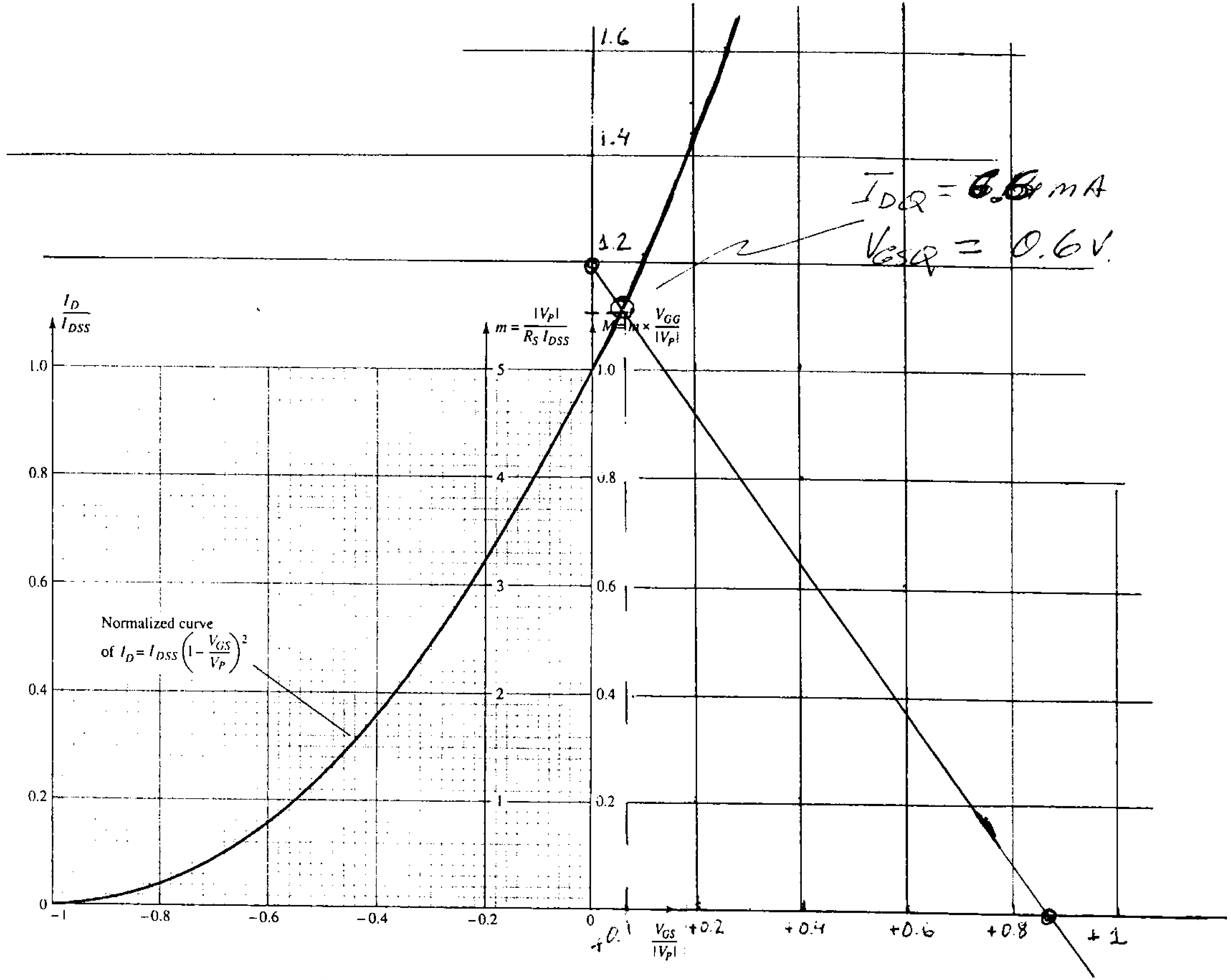


FIG. 7.60
Universal JFET bias curve.

Q6.- (Voir Ex 5.15. Probleme CH 5: 47-48)

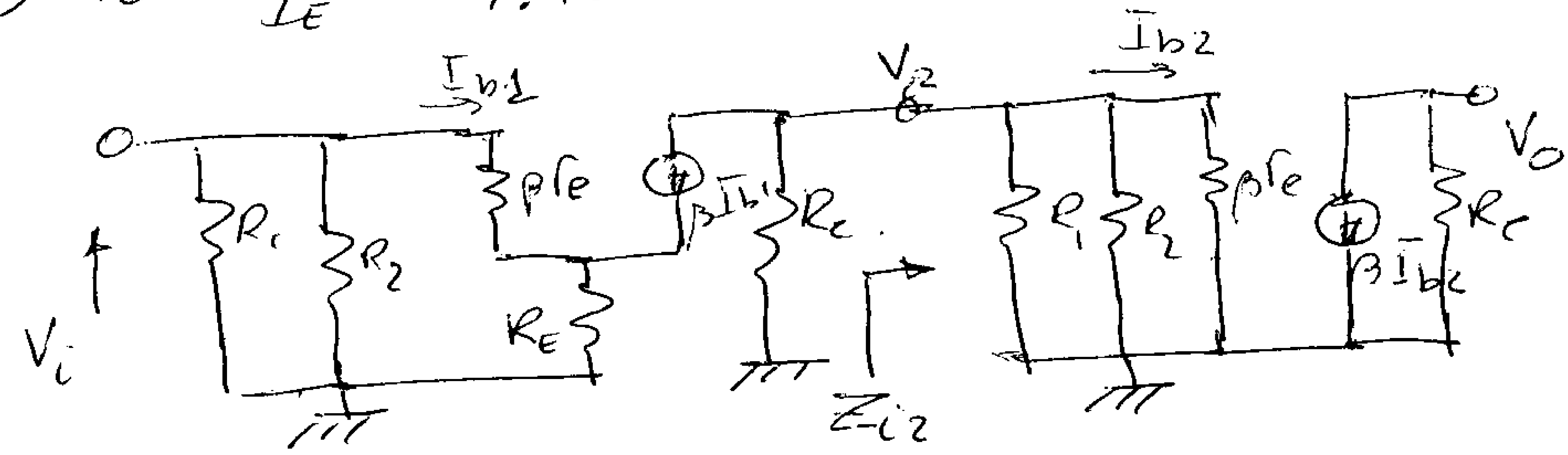
a) $\beta R_E > 10 R_2$ $\therefore V_B = \frac{15.8}{41} = 2.92\,V$

$V_E = 2.92 - 0.7 = 2.22$ $\quad I_E = \frac{2.22}{1.5K} = 1.48\,mA$.

$I_B = \frac{I_E}{\beta+1} = \frac{1.48\,mA}{151} = 9.8\,\mu A$

$I_C = \beta I_B = 150 \cdot 9.8 \cdot 10^{-3}\,mA = 1.47\,mA$.

b) $r_e = \frac{26mV}{I_E} = \frac{26}{1.48} = 17.56\,\Omega$



c) $A_{V2} = \frac{V_o}{V_{i2}} = -\frac{R_c}{r_e} = -\frac{2K}{17.56} = -114.3$

$Z_{i2} = R_1 \| R_2 \| \beta r_e = 1.8K$

$A_{V1} = \frac{V_{i2}}{V_i} = -\frac{R_c \| Z_{i2}}{r_e + R_E} = -\frac{2K \| 1.8K}{r_e + R_E} = -0.62$

$A_V = A_{V1} \cdot A_{V2} = 0.62 \cdot 114.3 = 70.8$

d) $Z_i = R_1 \| R_2 \| \beta(r_e + R_E) \approx R_1 \| R_2 = 6.22\,K\Omega$

$Z_0 = R_c \| r_o = R_c = 2\,K\Omega$