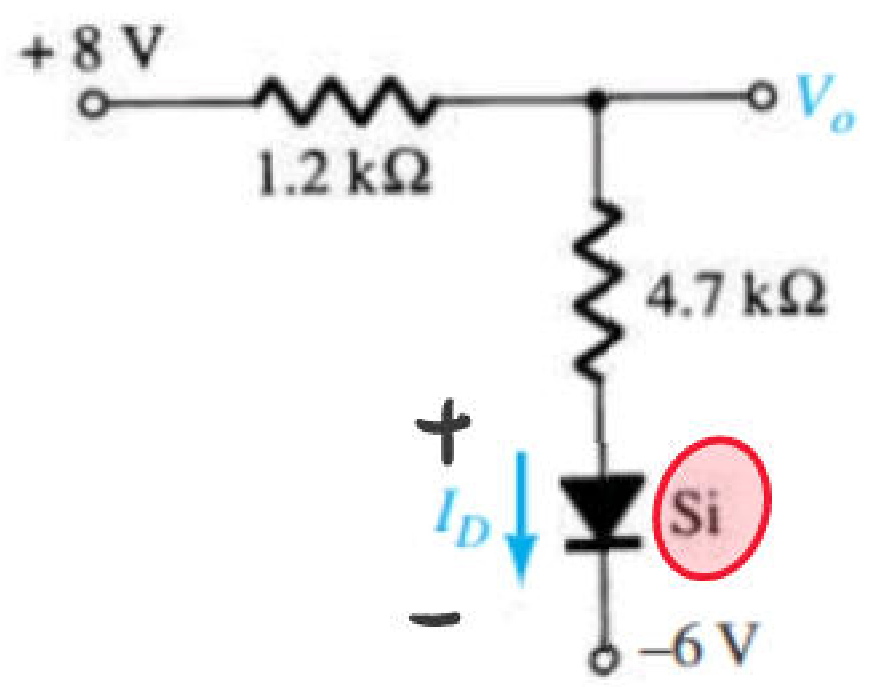
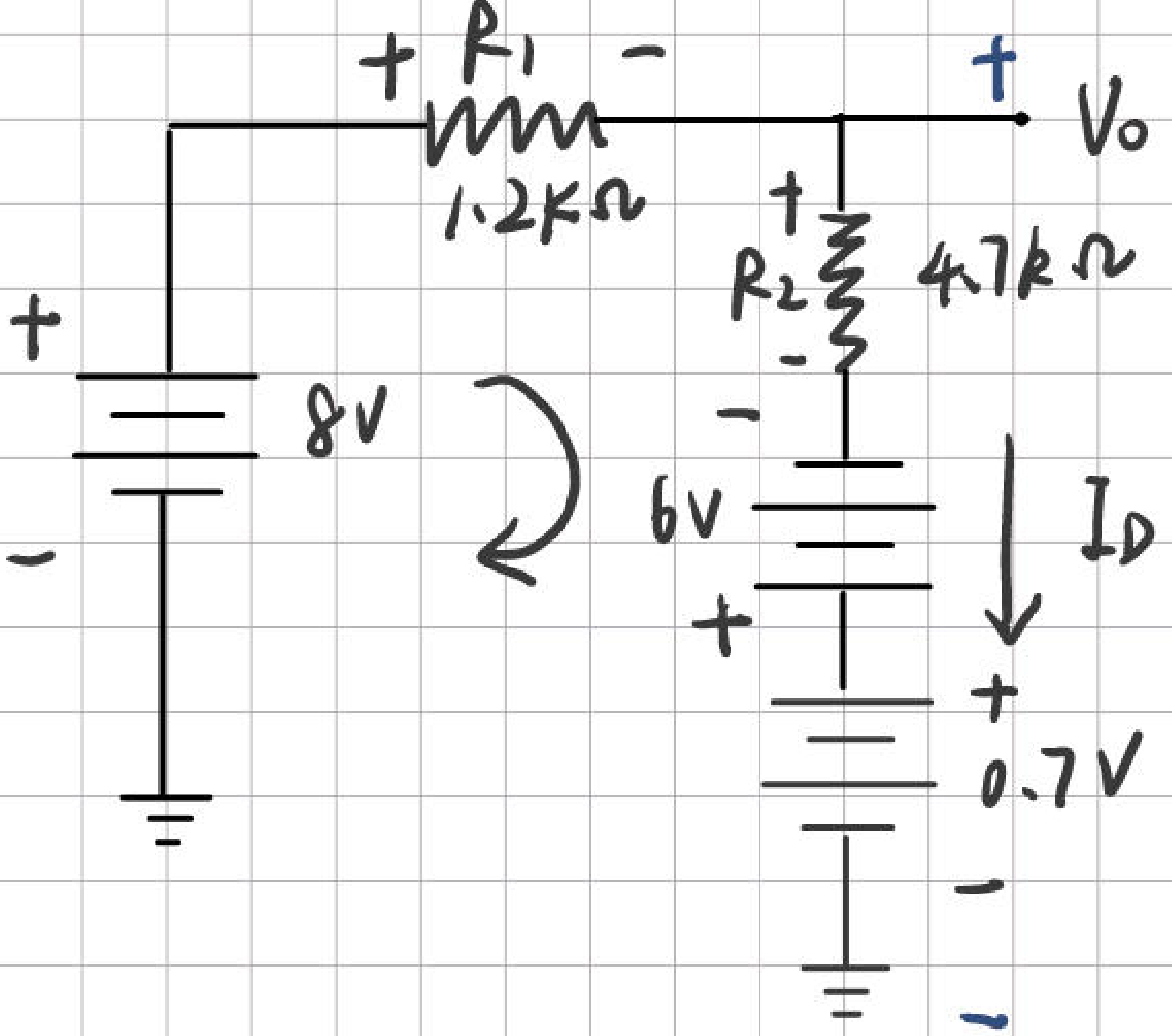
Determine the level of Vo for the network below.



Solution: The diode is on, the equivalent circuit is,



KVL:

$$R_1 \cdot I_D + R_2 \cdot I_D - 6 - 8 + 0.7 = 0$$

$$I_D \cdot (1.2k + 4.7k) = 13.3$$

$$I_D = \frac{13.3}{1.2k + 4.7k}$$

$$\approx 2.25\ mA$$

$$\therefore V_{R2} = I_D R_2$$

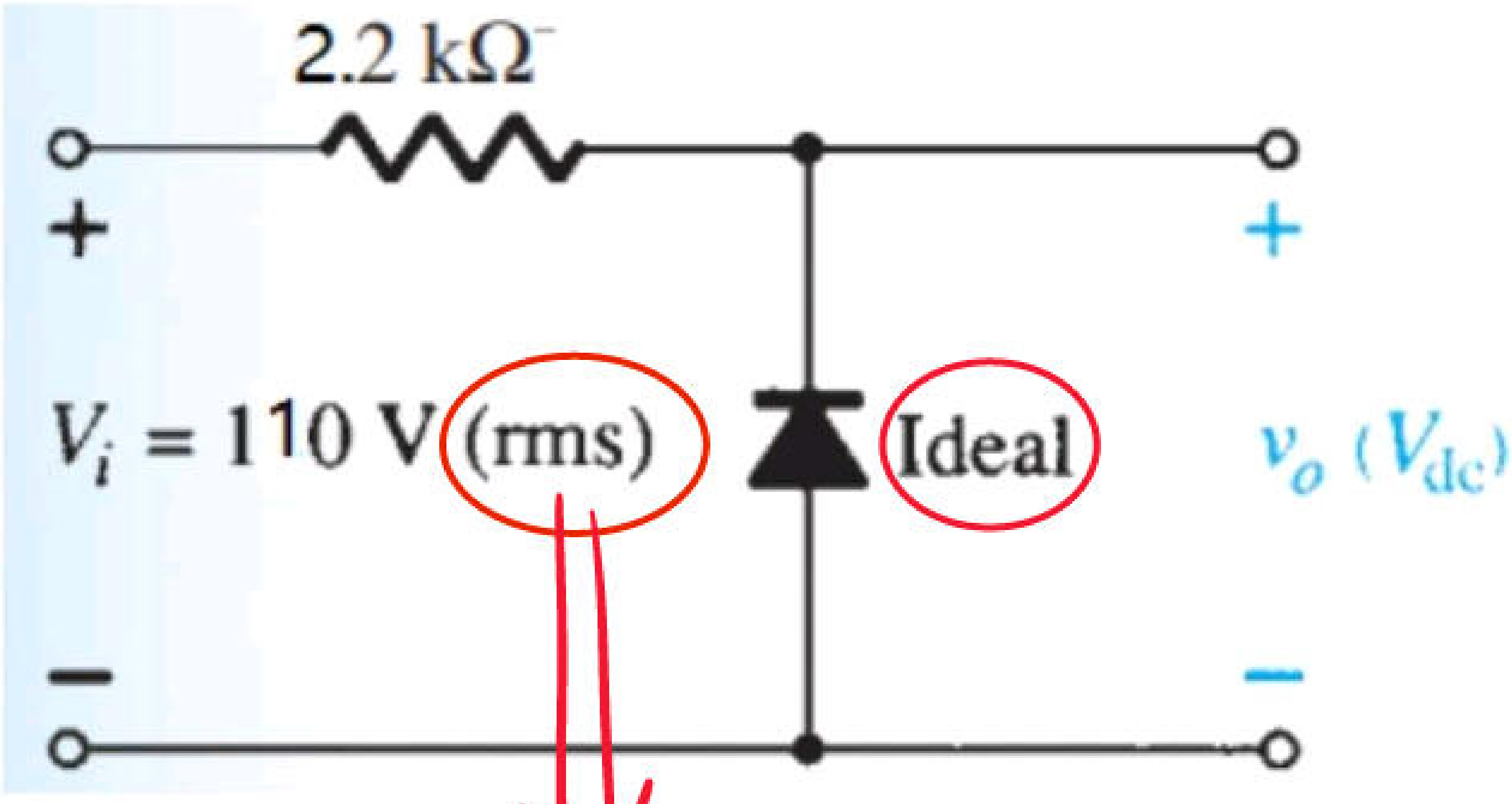
$$\approx 10.56\ V$$

KVL:

$$V_o - 0.7 + 6 - 10.56 = 0$$

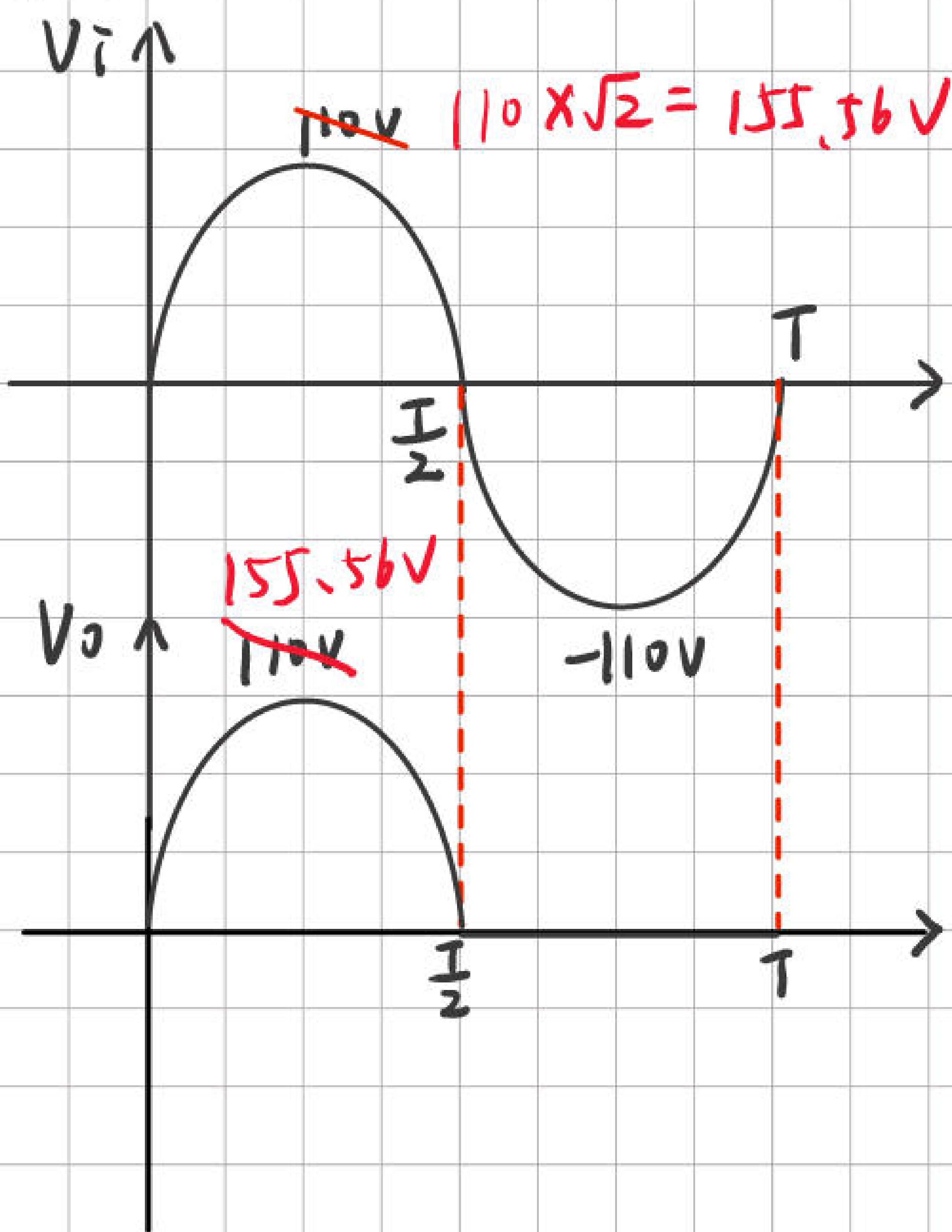
$$V_o = 5.26\ V$$

For the network of Fig.2.111, sketch vo and determine Vdc .



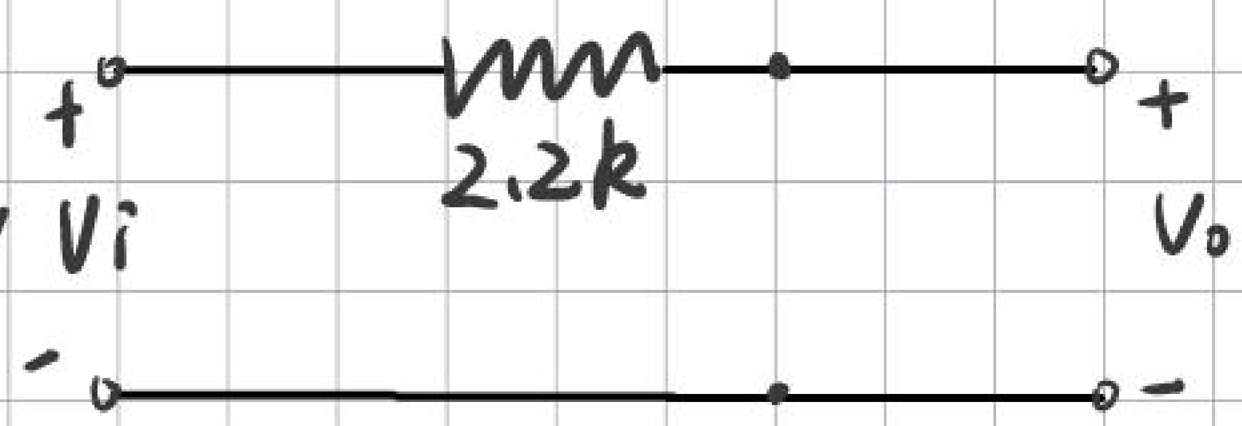
有效值

Solution:



1) $t = 0 \sim \frac{T}{2}$, D is off,

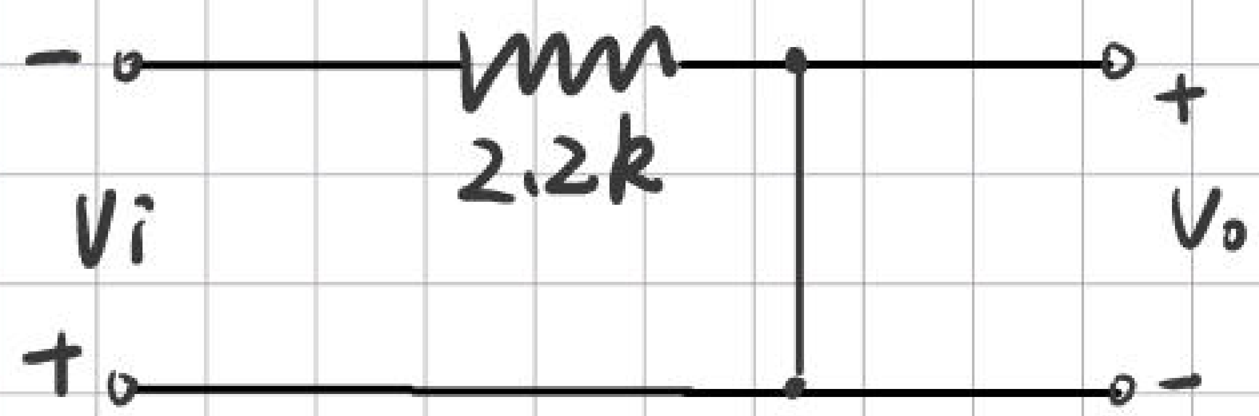
the equivalent circuit is,



$V_o = V_i$

2) $t = \frac{T}{2} \sim T$, D is on,

the equivalent circuit is,



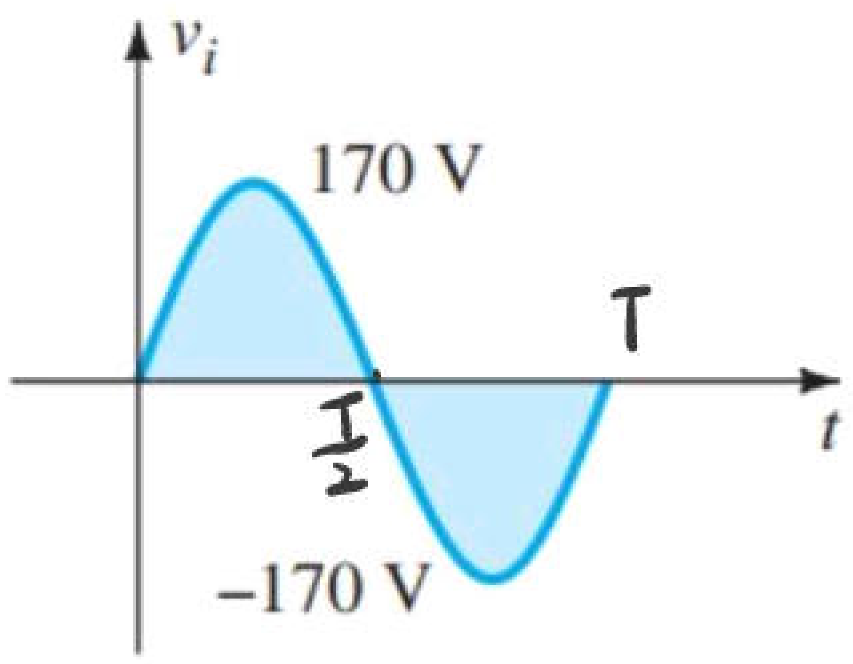
$V_o = 0$

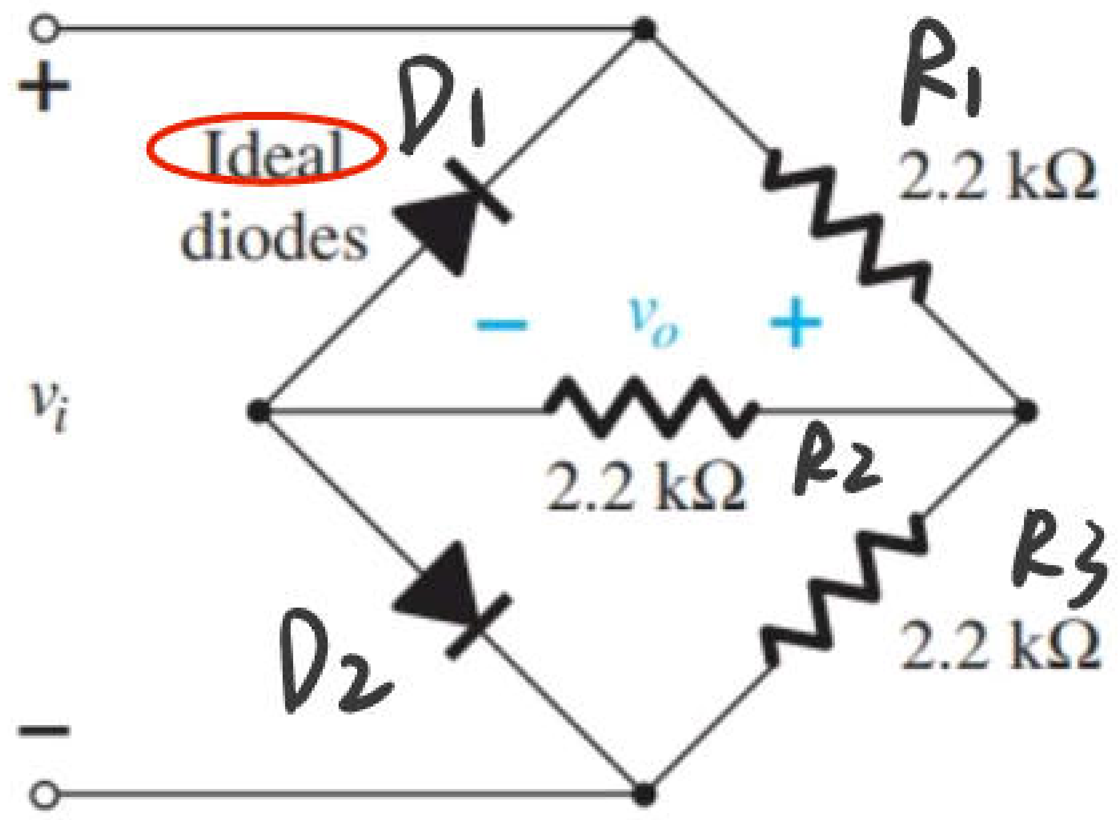
$\therefore V_{dc} = 0.318 V_m$

$= 155.56 \times 0.318$

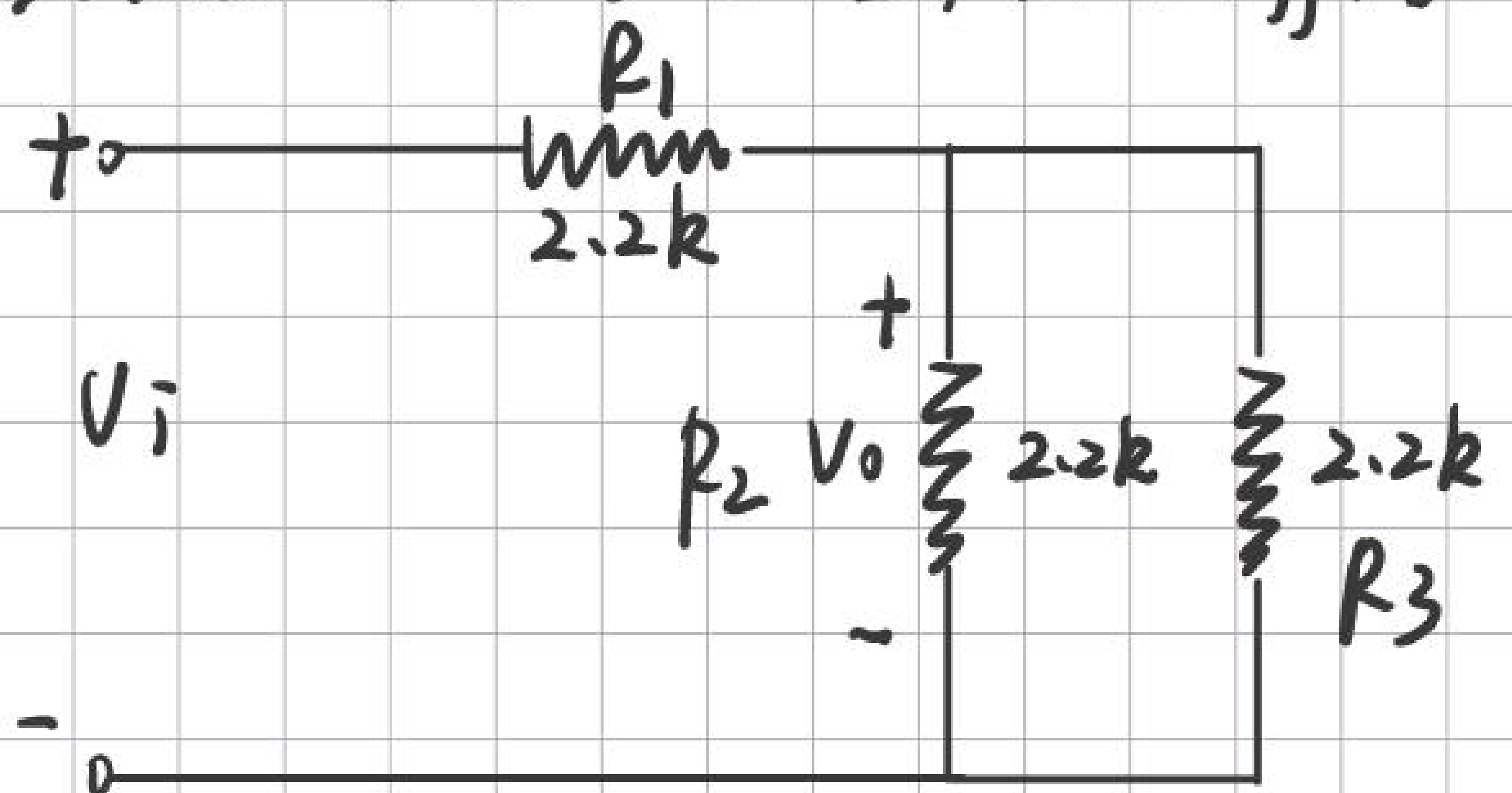
$\approx 49.47V$

Determine vo for the network of Fig. 2.116 and determine the dc voltage available.





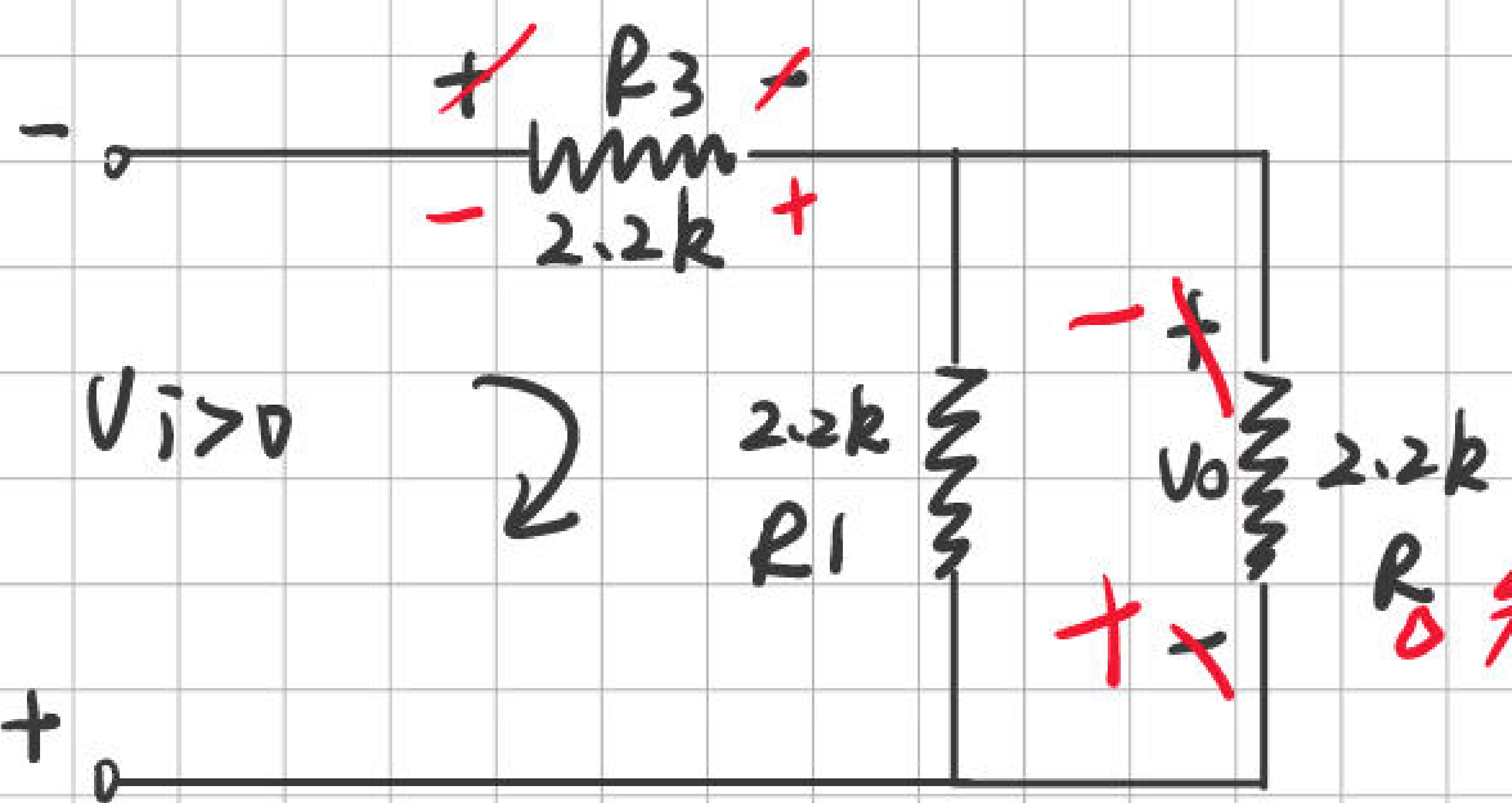
Solution: 1) $t=0\sim\frac{T}{2}$, D_1 is off, D_2 is on, the equivalent circuit is,



$$R_p=\frac{2.2k\cdot 2.2k}{2\cdot 2.2k}=1.1k\Omega$$

$$V_o=\frac{R_p}{R_1+R_p}V_i=\frac{1.1k}{3.3k}\cdot V_i=\frac{1}{3}V_i$$

2) $t=\frac{T}{2}\sim T$, D_1 is on, D_2 is off, the equivalent circuit is,



参考方向问题

$$R_p'=\frac{2.2k\cdot 2.2k}{2\cdot 2.2k}=1.1k\Omega$$

KVL: $U_{R3}+U_{Rp'}+V_i=0$

$2U_{Rp'}+U_{Rp'}=-V_i$

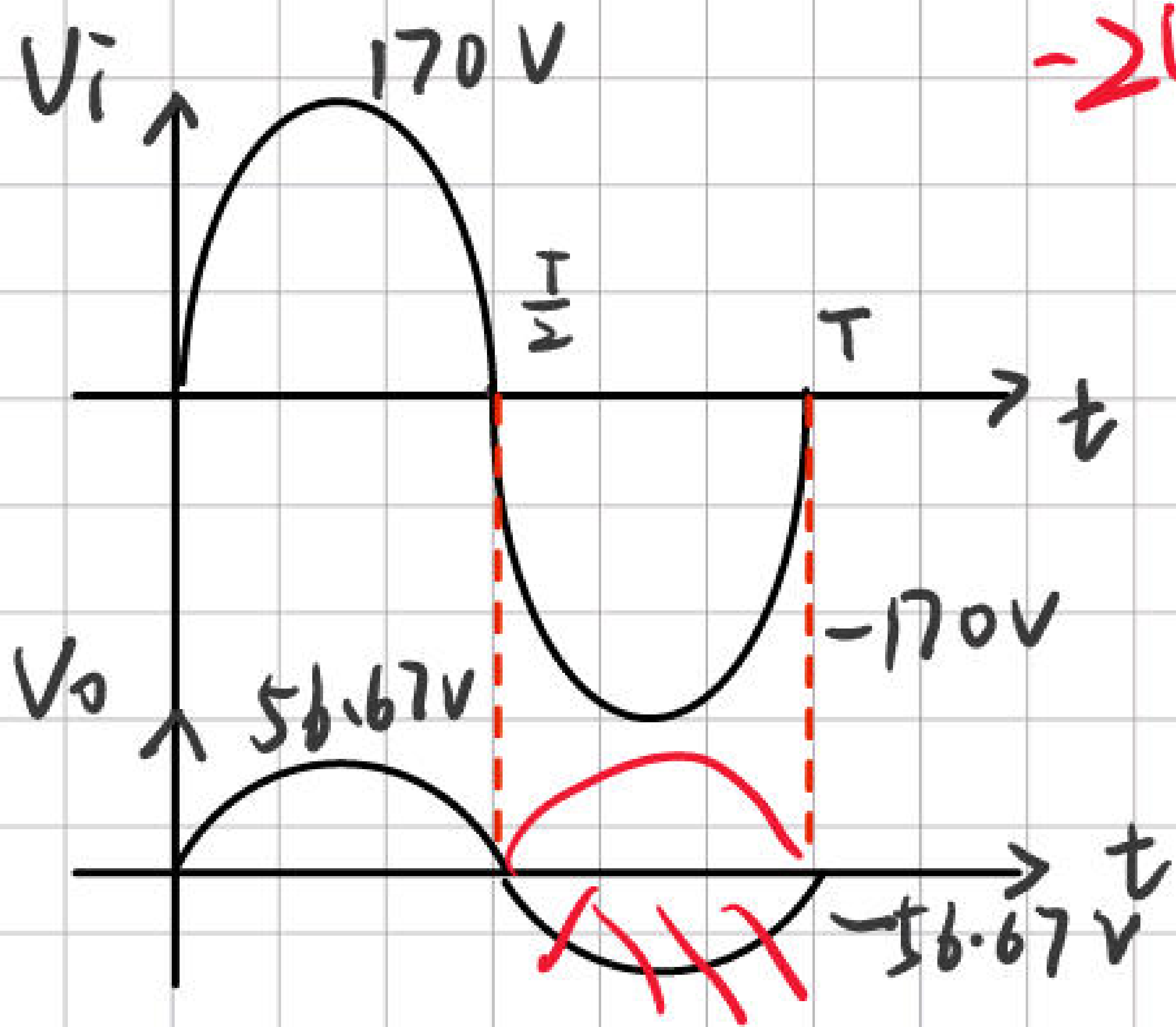
$U_0=U_{Rp'}=-\frac{V_i}{3}$

$\therefore V_o=-\frac{1}{3}V_i$

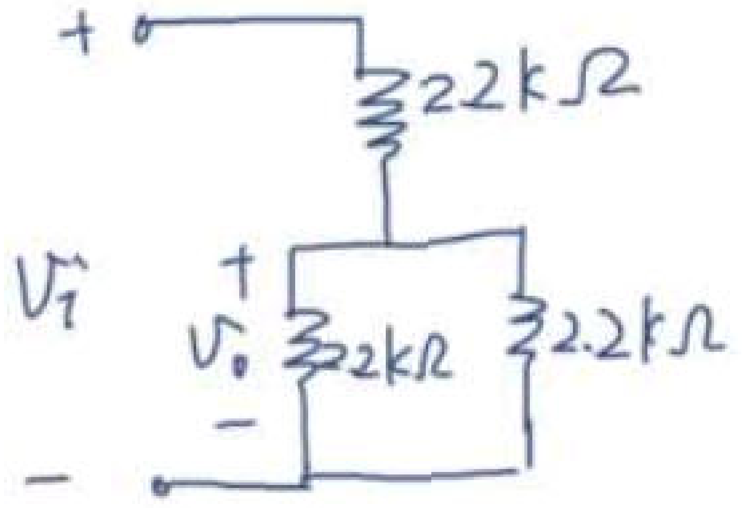
$-2V_i-V_o-V_i=0$

$V_o=-3V_i$

$V_i=-\frac{V_o}{3}$



$$V_{dc}=0.636V_m\approx 36.04V$$

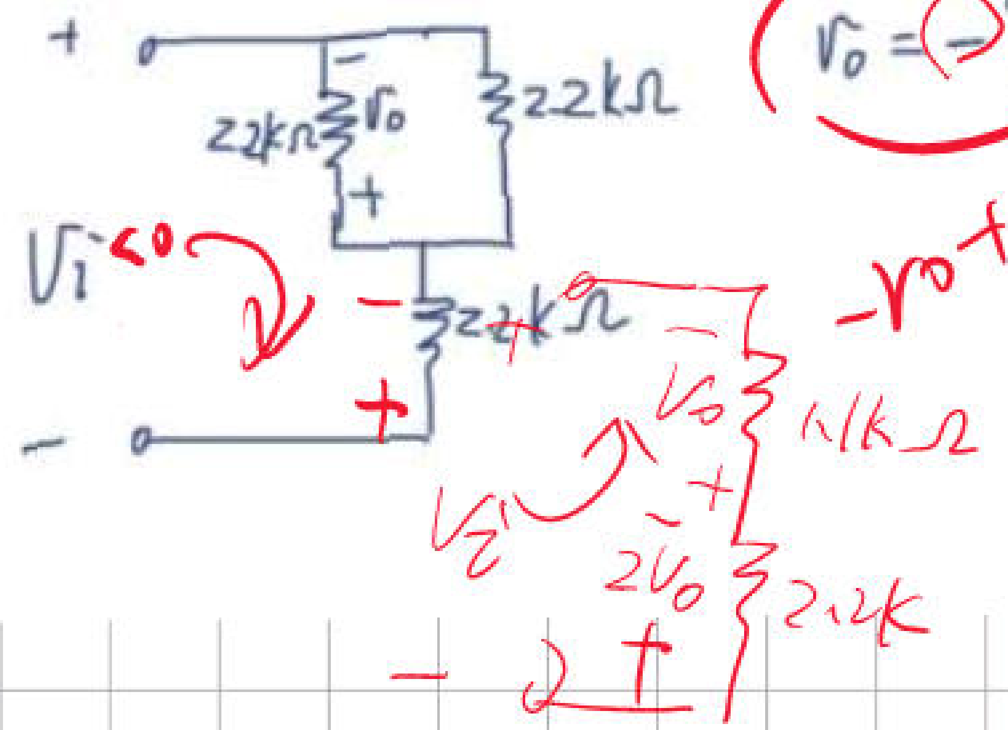


$V_{dc} = 0.636 \times 56.67$
$= 36.04\,V$

$v_o = \frac{1}{3} v_i$

$V_{om} = \frac{170}{3} \approx 56.67V$

for $t = \frac{T}{2} \sim T$, D_1 is on, D_2 is off



$v_o = -\frac{v_i}{3}$

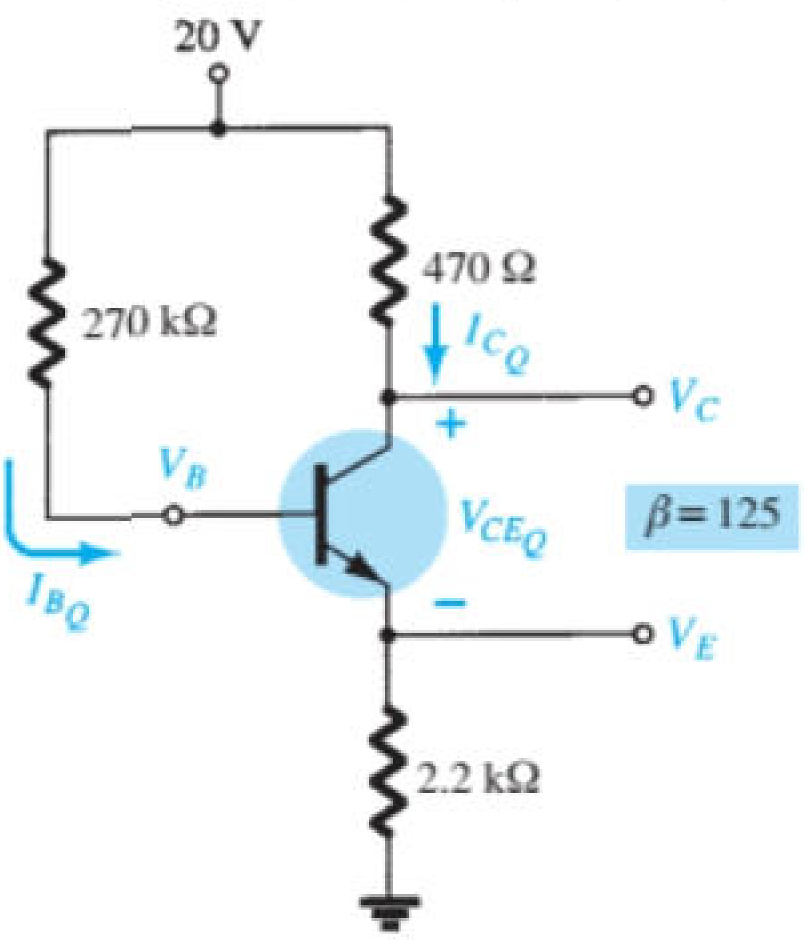
$-v_o + V_p - V_i = 0$

$V_p = V_i + v_o$

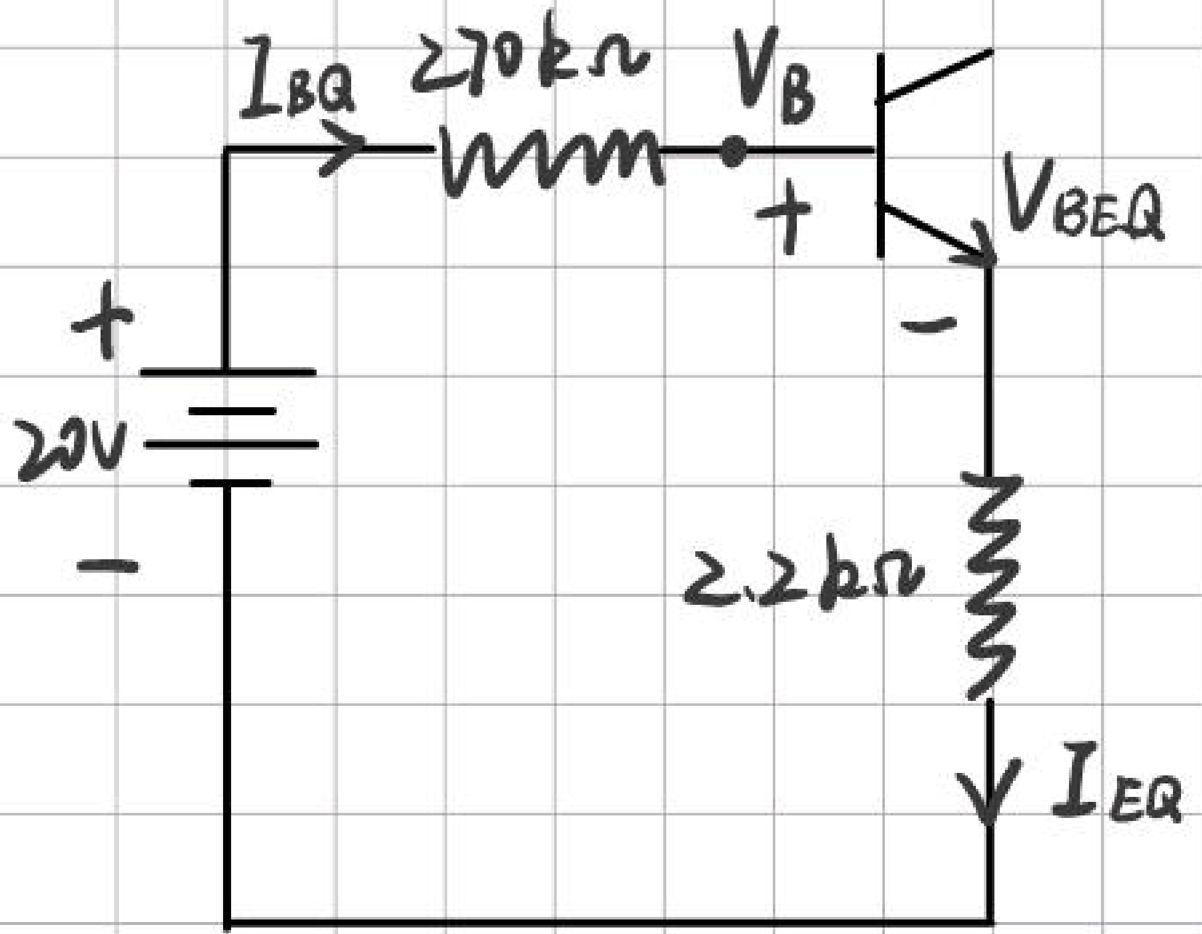
$V_i + 2V_o + V_o = V_s$

For the emitter bias circuit below, determine:

a. I_{BQ}.
b. I_{CQ}.
c. V_{CEQ}.
d. V_C.
e. V_B.
f. V_E.



solution:



a: $I_{BQ} = \dfrac{V_{CC} - V_{BEQ}}{R_B + (1+\beta)R_E}$

$= \dfrac{20 - 0.7}{270k + 126 \times 2.2k}$

$\approx 35.27\ \mu A$

b: $I_{CQ} = \beta I_{BQ}$

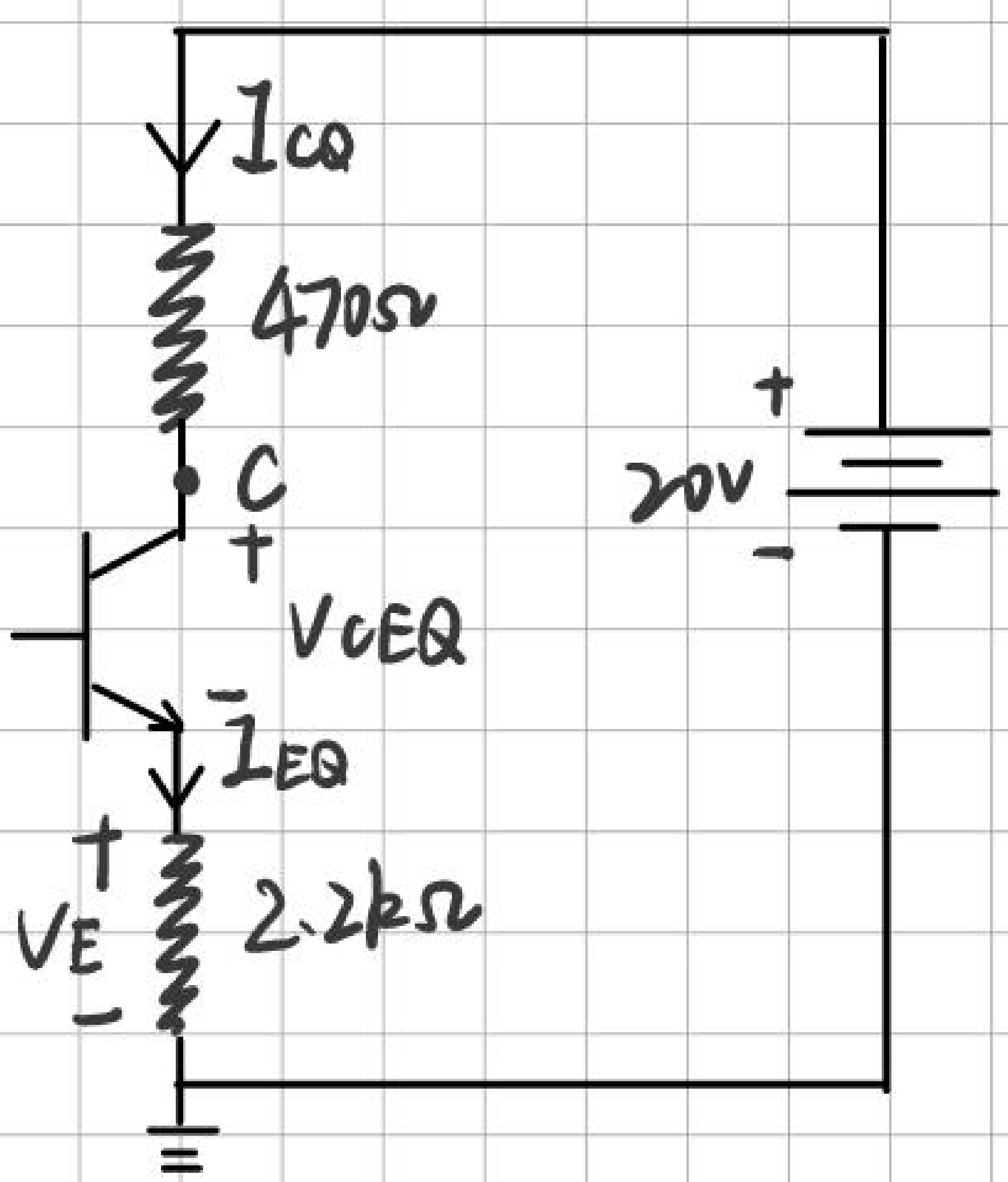
$= 4.41\ mA$

Since $I_{CQ} \cong I_{EQ}$

c: $V_{CEQ} \approx V_{CC} - I_{CQ}(R_C + R_E)$

$\approx 20 - 4.41(0.47 + 2.2)$

$\approx 8.23\ V$



d: $V_C = V_{CEQ} + V_E$

$= 8.23 + 9.77$

$= 18\ V$

f: $V_E = I_{EQ} \cdot R_E$

$= (1+\beta) I_{BQ} \cdot R_E$

$= 126 \times 35.27\ \mu A \cdot 2.2k\Omega$

$\approx 4.44\ mA \cdot 2.2k\Omega$

$\approx 9.77\ V$

e: $V_B = V_{BEQ} + I_{EQ} \cdot R_E$

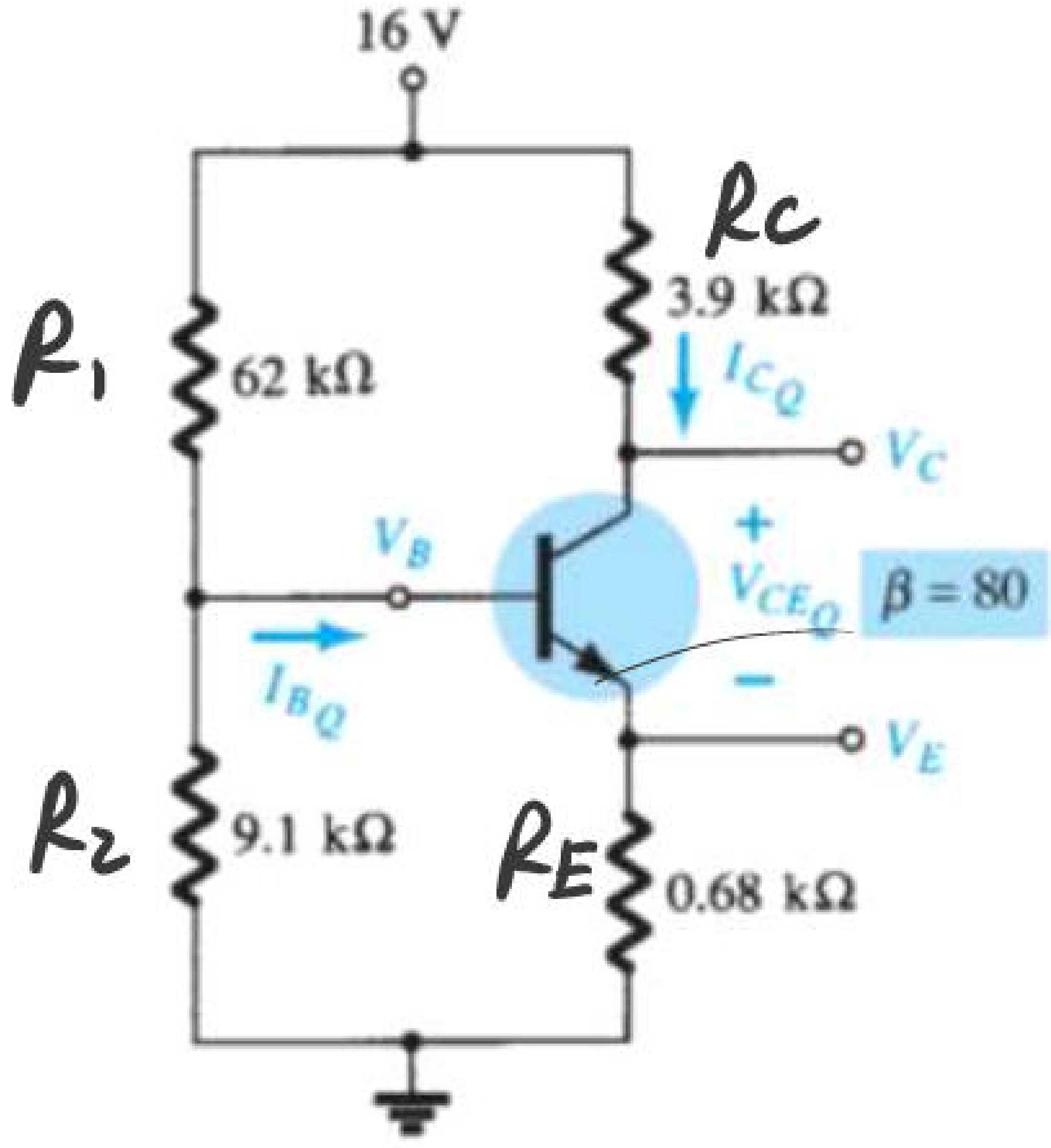
$= 0.7 + 9.77$

$= 10.47\ V$

2. 计算题

For the voltage-divider bias configuration, determine:

a. I_{BQ}.
b. I_{CQ}.
c. V_{CEQ}.
d. V_C.
e. V_E.
f. V_B.

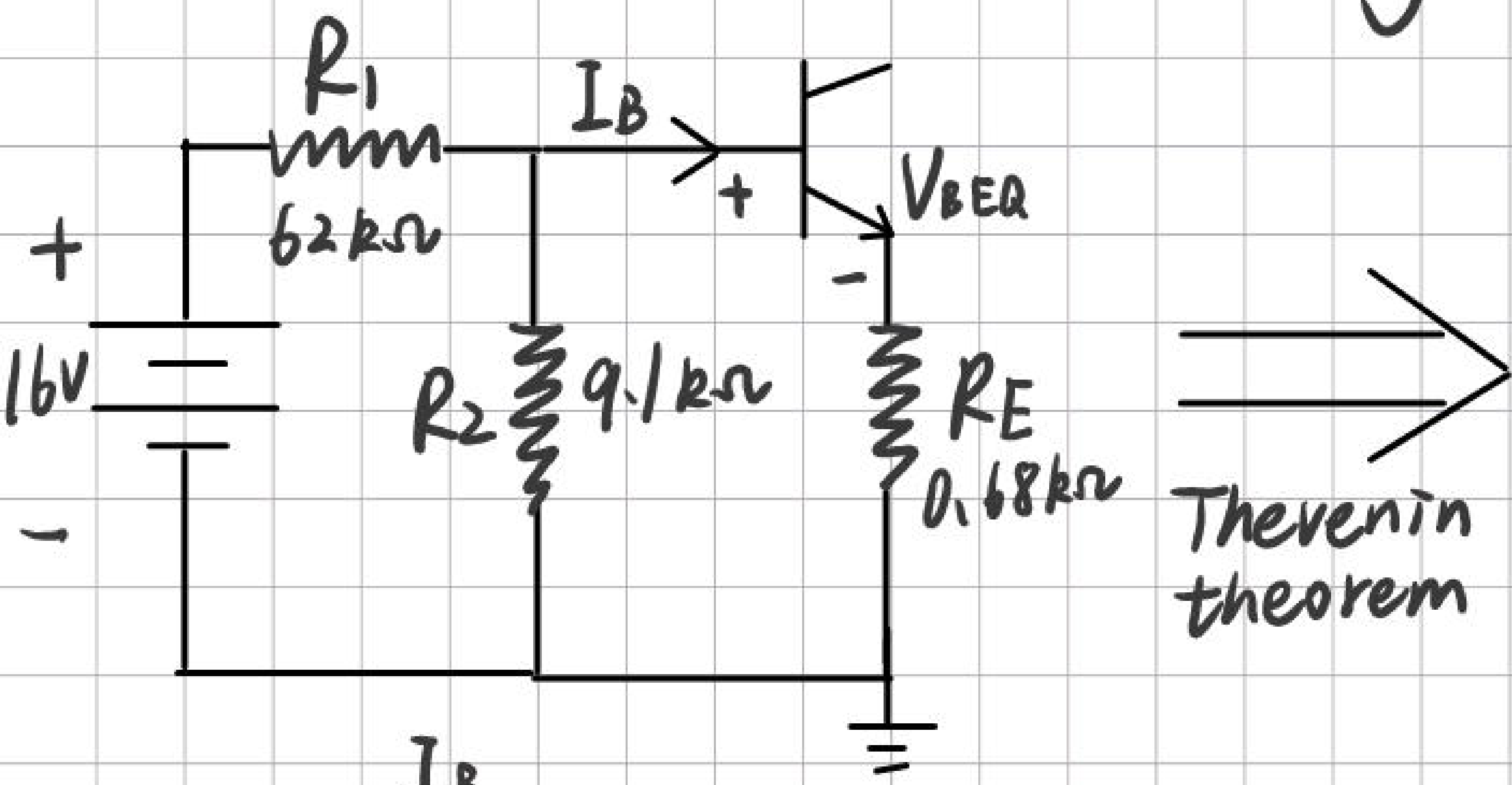


Solution: $\beta R_E = 80 \times 0.68k\Omega = 54400\Omega$

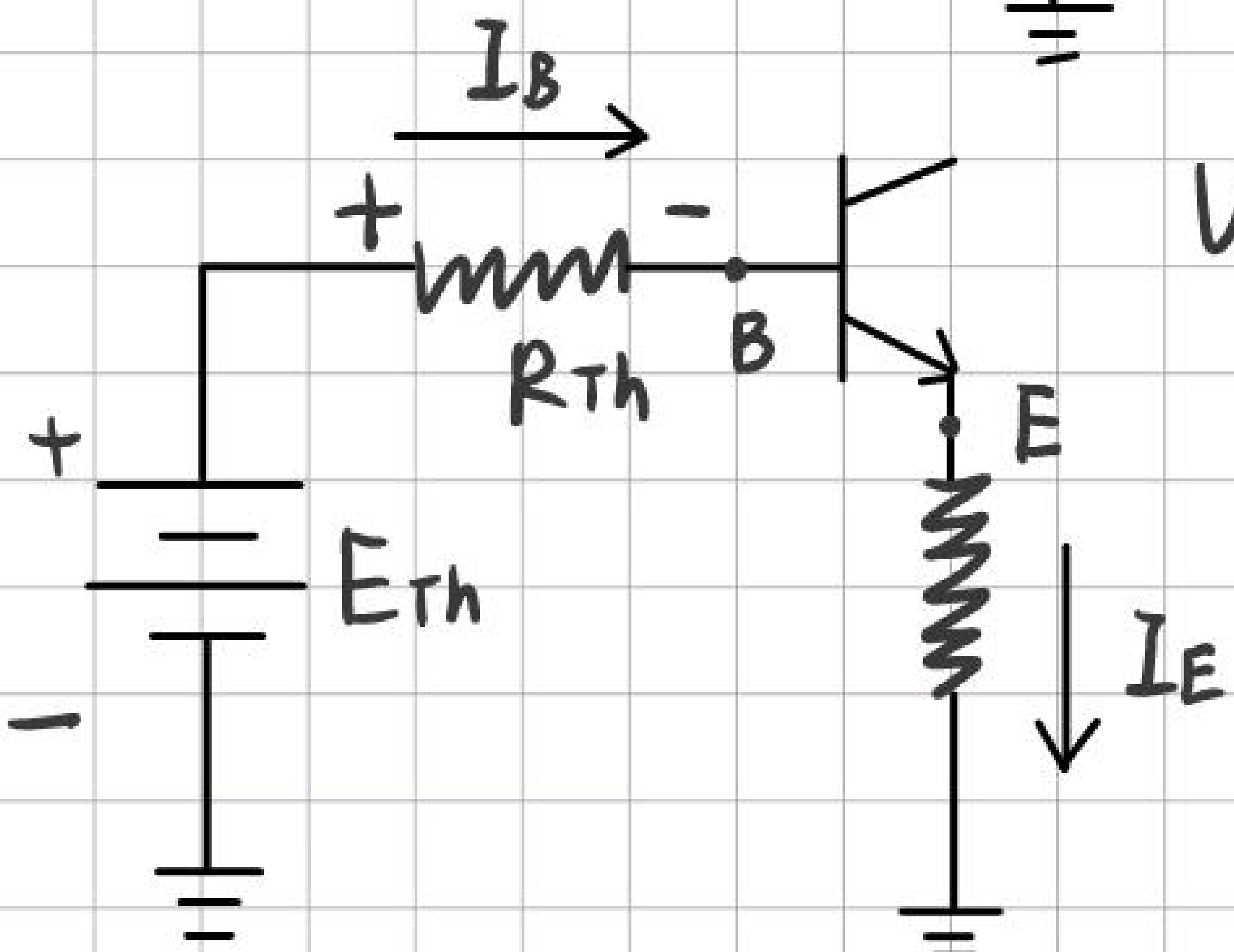
$10R_2 = 91000\Omega$

$10R_2 > \beta R_E$

$\therefore \beta R_E \not\geq 10R_2$ ∴ Using exact analysis



$$R_{Th} = R_1 \parallel R_2 = \frac{R_1 R_2}{R_1 + R_2} = \frac{62k \cdot 9.1k}{62k + 9.1k} \approx 7935.30\,\Omega$$



$$V_E = I_{EQ} \cdot R_E = (1+\beta) I_{BQ} \cdot R_E = 81 \times 21.42\mu A \cdot 0.68k\Omega \approx 1.18V$$

$$E_{Th} = \frac{R_2 V_{cc}}{R_1 + R_2} = \frac{9.1k \times 16}{62k + 9.1k} \approx 2.05V$$

a: $I_{BQ} = \dfrac{E_{Th} - V_{BEQ}}{R_{Th} + (1+\beta) R_E} = \dfrac{2.05 - 0.7}{7935.30 + 81 \times 680} \approx 21.42\mu A$

b: $I_{CQ} = \beta I_{BQ} \approx 1.71\,mA$

c: $V_{CEQ} = V_{cc} - I_{CQ}(R_c + R_E) = 16 - 1.71(3.9 + 0.68) \approx 8.17V$

d: $V_C = V_{CEQ} + V_E = 8.17 + 1.18 = 9.35\,V$

e: $V_E = 1.18V$

f: $V_B = V_{BEQ} + V_E = 0.7 + 1.18 = 1.88V$

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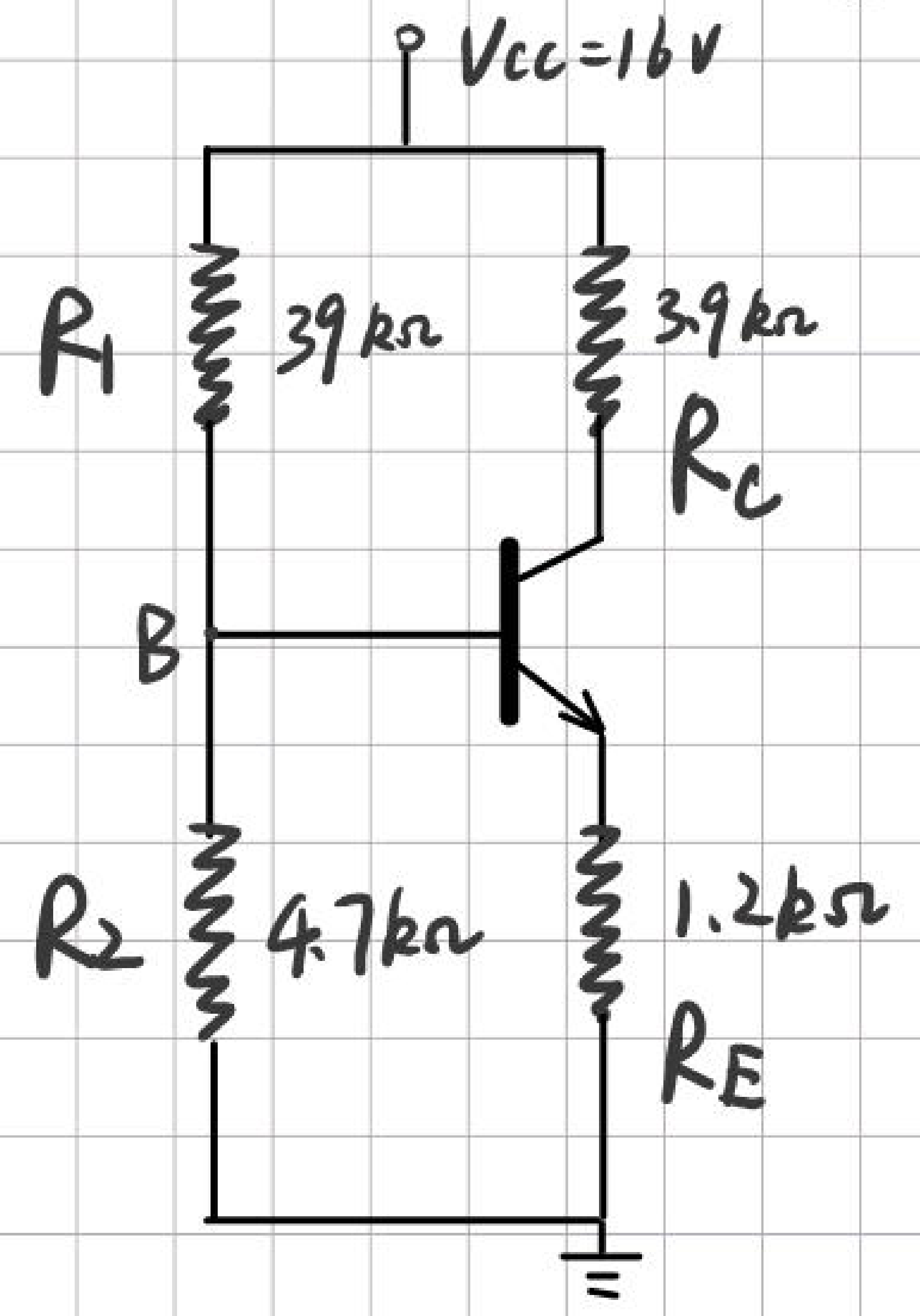
$\beta R_E = 100 \times 1.2k = 120k$

$10R_2 = 47k\Omega$

$\Rightarrow \beta R_E > 10R_2$

Using approximate analysis:

sketch the DC biasing circuit:



$$V_B = \frac{R_1}{R_1+R_2} V_{CC} = \frac{39K}{4.7K+39K} \times 16 \approx 14.28V$$

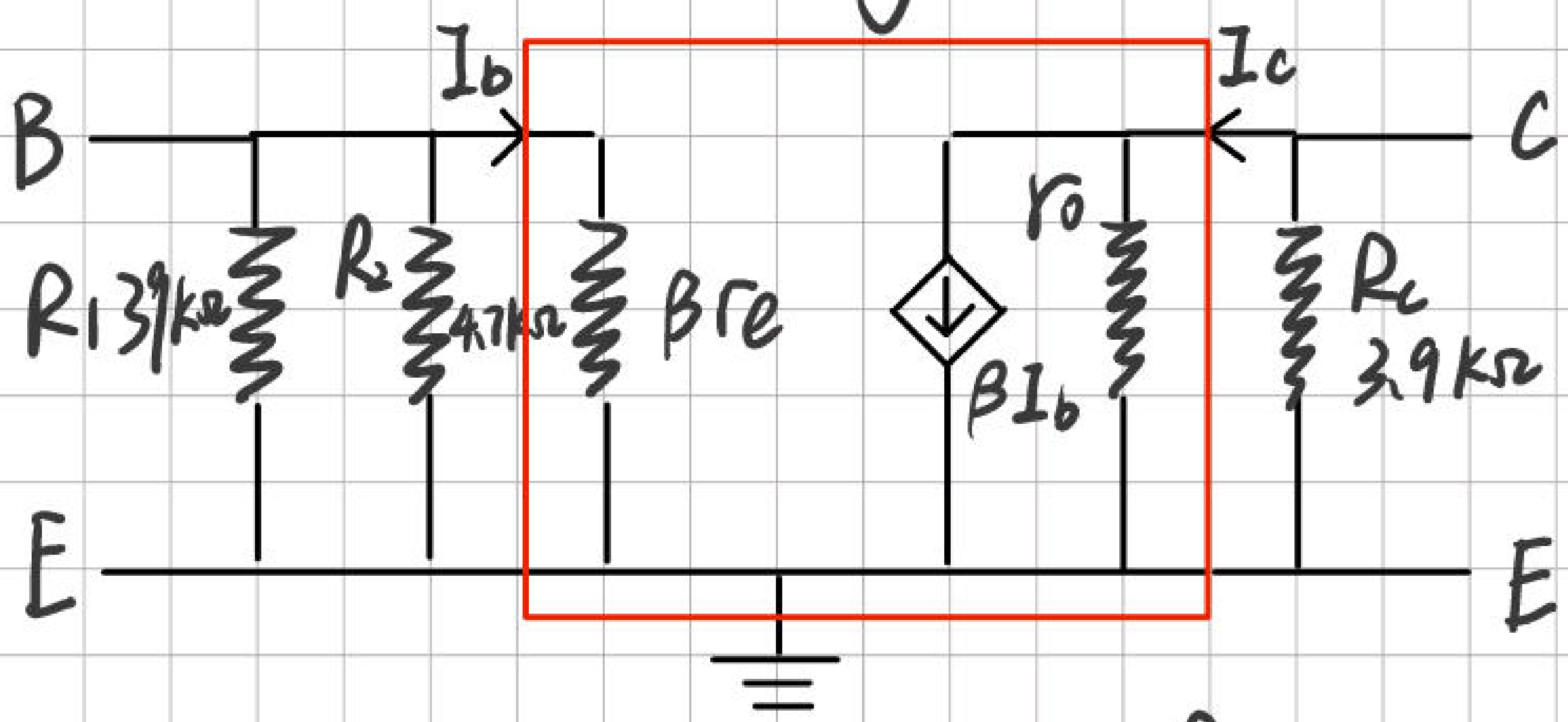
$$V_B = V_{BEQ} + V_E = 0.7 + I_{EQ} \cdot R_E$$

$$I_{EQ} \cdot 1.2k = 13.58$$

$$I_{EQ} \approx 11.31mA$$

a. $$r_e = \frac{26mV}{I_{EQ}} = \frac{26mV}{11.31mA} \approx 2.30\Omega$$

sketch the AC biasing circuit:



b. $Z_i = R_1 // R_2 // \beta r_e$

$$= \frac{1}{\frac{1}{39K} + \frac{1}{4.7K} + \frac{1}{100 \times 2.30}}$$

$\approx 218.04\Omega$

$\approx 0.22k\Omega$

$r_o = 50k\Omega > 10R_C$

$Z_o = r_o // R_C$

$\approx R_C$

$\approx 3.9k\Omega$

c. $$A_v = -\frac{r_o // R_C}{r_e} \approx -\frac{R_C}{r_e} = -1695.65$$

d. if $r_o = 25k\Omega < 10R_C$

$Z_i = 0.22k\Omega$ $\quad Z_o = r_o // R_C = \frac{25K \times 3.9K}{25K + 3.9K} \approx 3.37k\Omega$

$$A_v = -\frac{Z_o}{r_e} = -\frac{3.37K}{2.30} \approx -1465.22.$$

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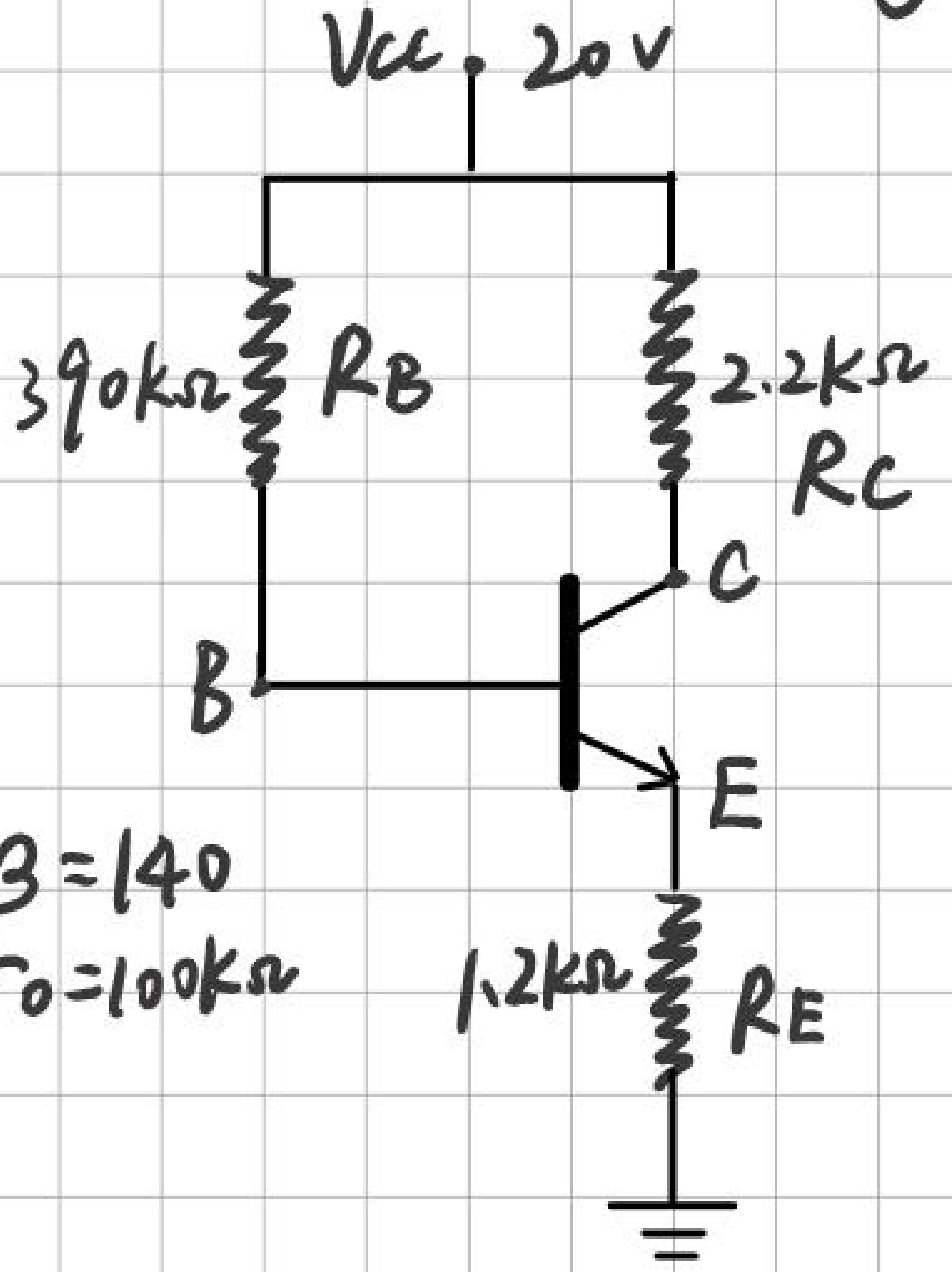
a. Sketch the DC biasing circuit:



$\beta = 140$

$r_o = 100k\Omega$

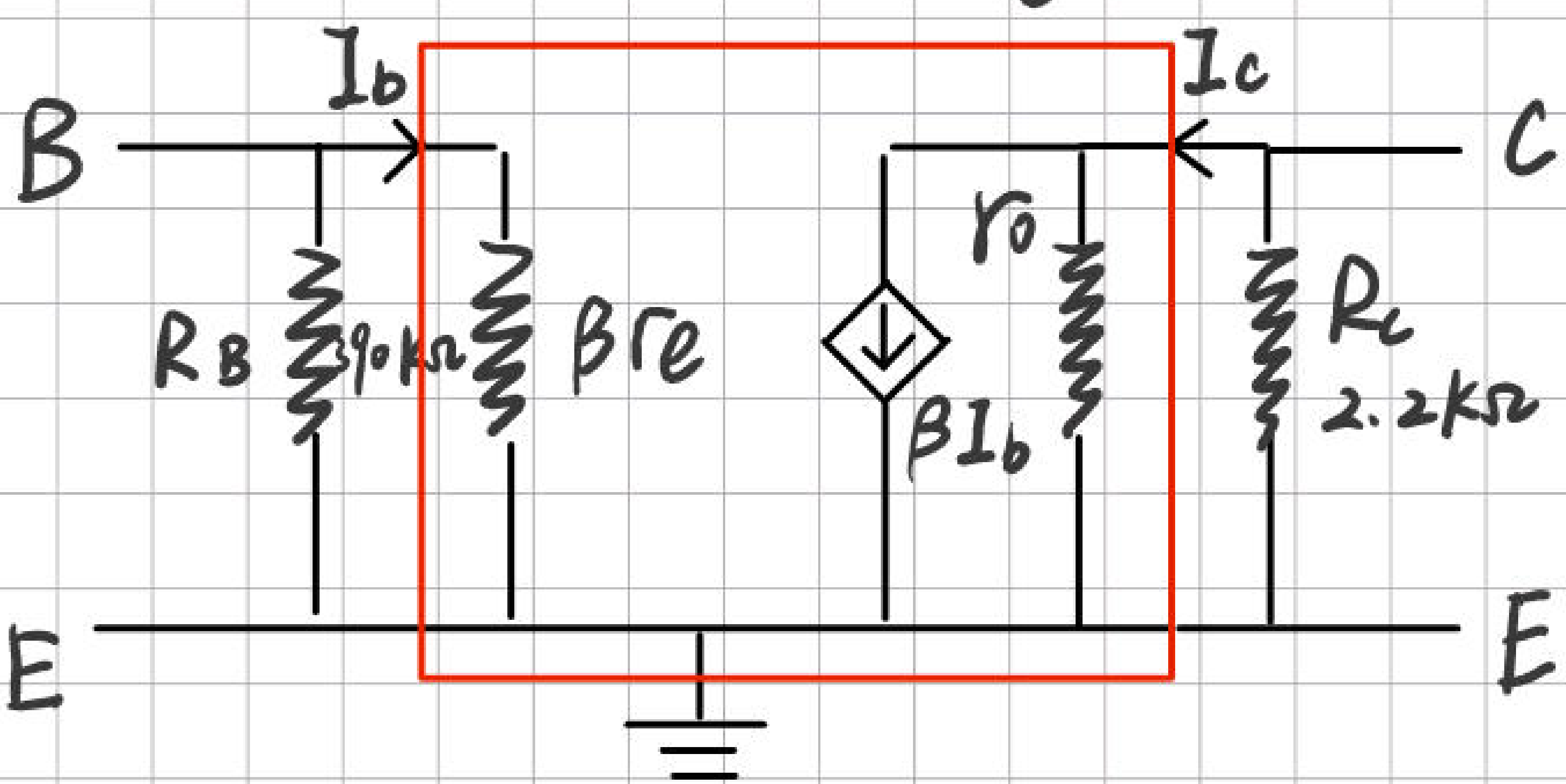
$-V_{CC} + V_{BEQ} + I_{BQ} \cdot R_B + I_{EQ} \cdot R_E = 0$

$$I_{BQ} = \frac{V_{CC} - V_{BEQ}}{R_B + (1+\beta) R_E} = \frac{20 - 0.7}{390k + 141 \times 1.2k} \approx 34.51 \mu A$$

$$I_{EQ} = (1+\beta) I_{BQ} = 141 \times 34.51 \mu A \approx 4.87 mA$$

$$r_e = \frac{26mV}{I_{EQ}} = \frac{26mV}{4.87mA} \approx 5.34\Omega$$

b. sketch the AC biasing circuit:



$R_B = 390k\Omega > 10\beta r_e = 7476\Omega$

$Z_i = R_B // \beta r_e$

$\approx \beta r_e$

$\approx 747.6\Omega \approx 0.75k\Omega$

$r_o > 10 R_C$

$Z_o = r_o // R_C$

$\approx r_c$

$\approx 2.2k\Omega$

c. $A_v = \frac{-Z_o}{r_e} \approx -\frac{2.2k}{5.34} \approx 411.99$

d. if $r_o = 20k\Omega$

$Z_i = 0.75k\Omega \quad r_o < 10 R_C$

$Z_o = r_o // R_C = \frac{20k \times 2.2k}{20k + 2.2k} \approx 1981.98\Omega \approx 1.98k\Omega$

$A_v = -\frac{Z_o}{r_e} = \frac{1.98k}{5.34} \approx 370.79$

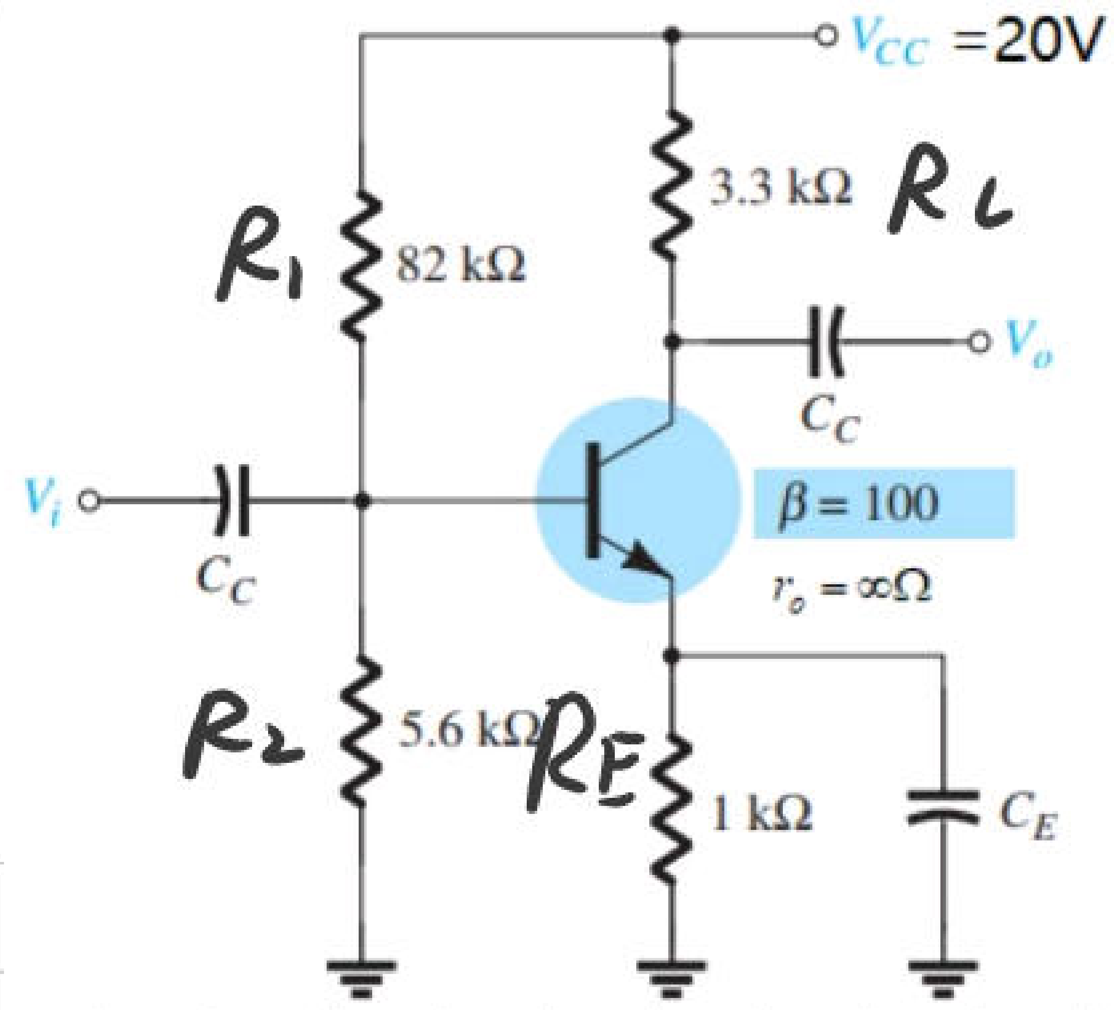
For the network below:

a. Determine I_{BQ}, I_{CQ}, I_{EQ}, V_{CEQ}, V_C, V_E.

b. Determine re

c. Sketch the AC equivalent cirtuit.

d. Determine Z_i, Z_o and A_v.



Solution:

a. $\beta re = 100 \times 1K = 100K\Omega$

$10R_2 = 10 \times 5.6k = 56k\Omega$

$\beta re > 10R_2$

$\therefore$ Using approximate analysis

$$V_B = \frac{R_2}{R_1+R_2} V_{CC} = \frac{5.6K}{82K+5.6K} \times 20 \approx 1.28V$$

$$V_E = V_B - V_{BEQ} = 1.28 - 0.7 = 0.58V$$

$$I_{EQ} = \frac{V_E}{R_E} = \frac{0.58}{1K} = 0.58\,mA$$

$$I_{BQ} = \frac{I_{EQ}}{1+\beta} \approx 5.74\,\mu A$$

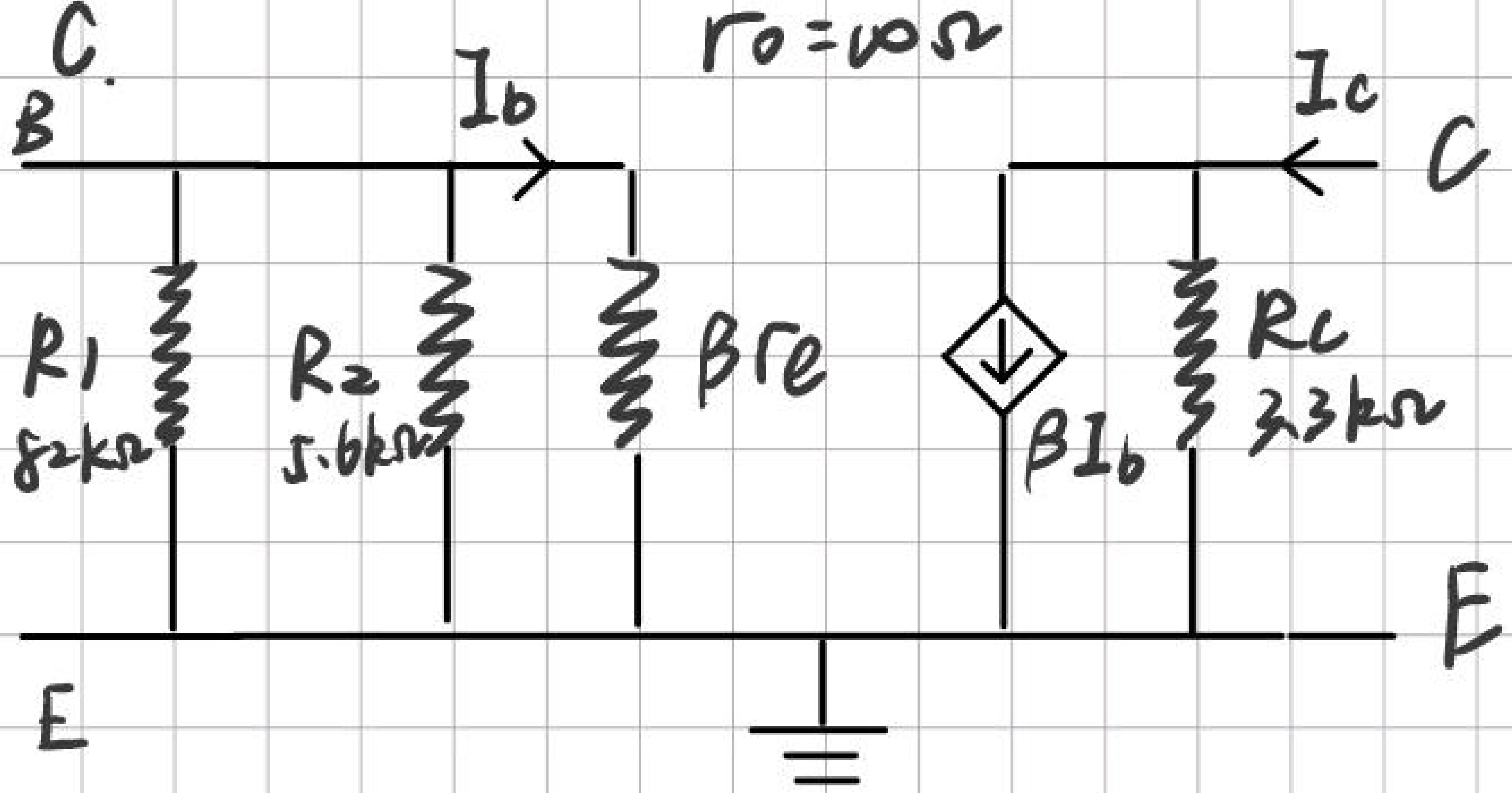
$I_{CQ} \approx I_{EQ} = 0.58mA$

$$V_{CEQ} = V_{CC} - I_{CQ}(R_C + R_E)$$
$$= 20 - 0.58mA \times 4.3K$$
$$\approx 17.51V$$

$$V_C = I_{CQ} \cdot R_C = 0.58mA \times 3.3k\Omega$$
$$\approx 1.91V$$

b. $re = \frac{26mV}{I_{EQ}} = \frac{26mV}{0.58mA} \approx 44.83\Omega$

c.



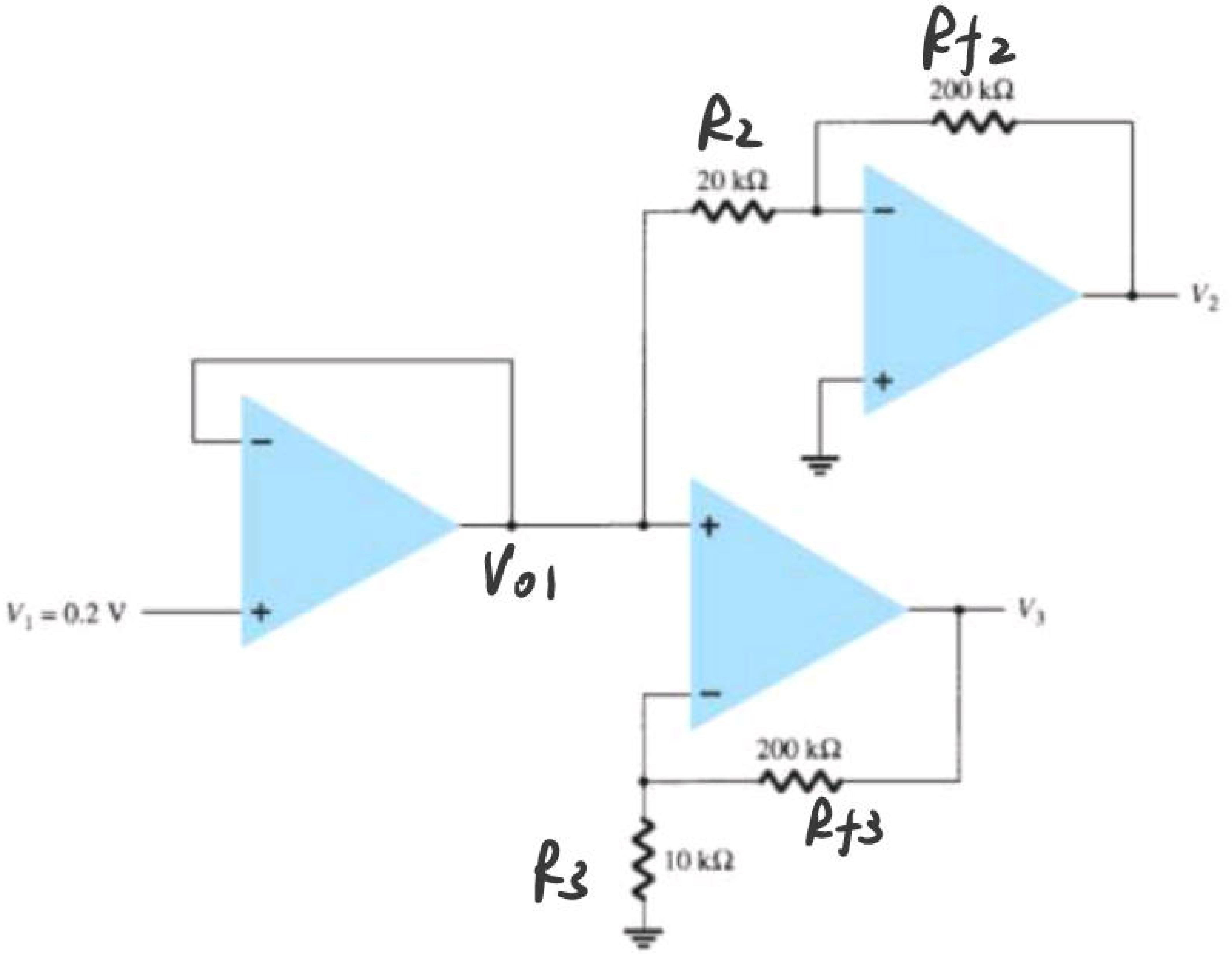
d. $$R_1 // R_2 = \frac{R_1 R_2}{R_1 + R_2} = \frac{82k \times 5.6k}{82k + 5.6k} \approx 5242.01\Omega \approx 5.24k\Omega$$

$$Z_i = R_1 // R_2 // \beta re = \frac{5242.01 \times 100 \times 44.83}{4483 + 5242.01} \approx 2.42k\Omega$$

$$Z_o = R_C = 3.3k\Omega$$

$$A_v = -\frac{Z_o}{re} = -\frac{3.3k}{44.83} \approx -73.61$$

Calculate the output voltages V2 and V3 in the circuit。

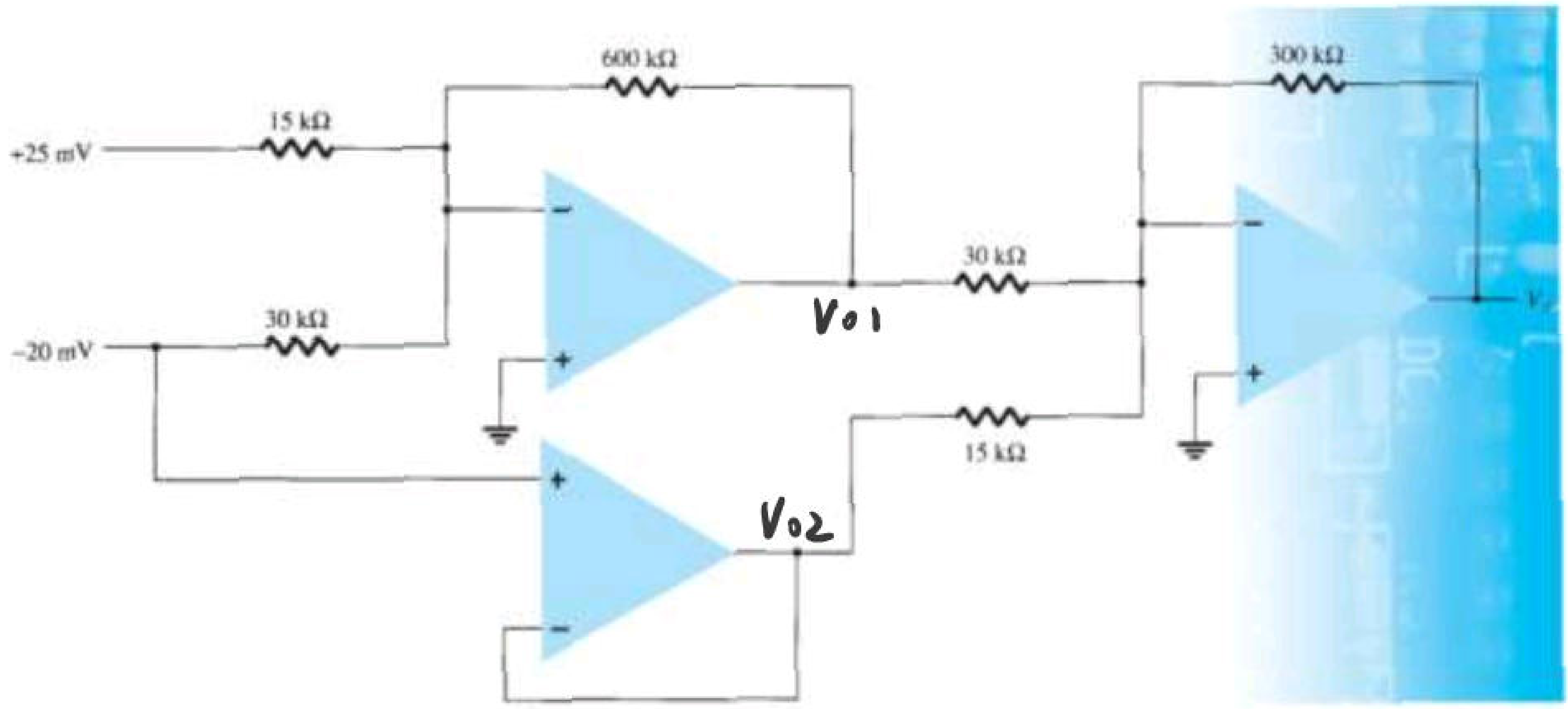


solution: $V_{o1} = V_1 = 0.2V$

$$V_3 = \left(1 + \frac{R_{f3}}{R_3}\right) V_{o1}$$
$$= \left(1 + \frac{200k}{10k}\right) \times 0.2$$
$$= 21 \times 0.2$$
$$\approx 4.2V$$

$$V_2 = -\frac{R_{f2}}{R_2} V_{o1}$$
$$= -\frac{200k}{20k} \times 0.2$$
$$= -2V$$

Calculate V_o in the circuit below .



Solution:

$$V_{o1} = -\left(\frac{600k}{15k} \times 25mV + \frac{600k}{30k} \times -20mV\right) \qquad V_{o2} = -20mV$$

$$= -(1000mV - 400mV)$$

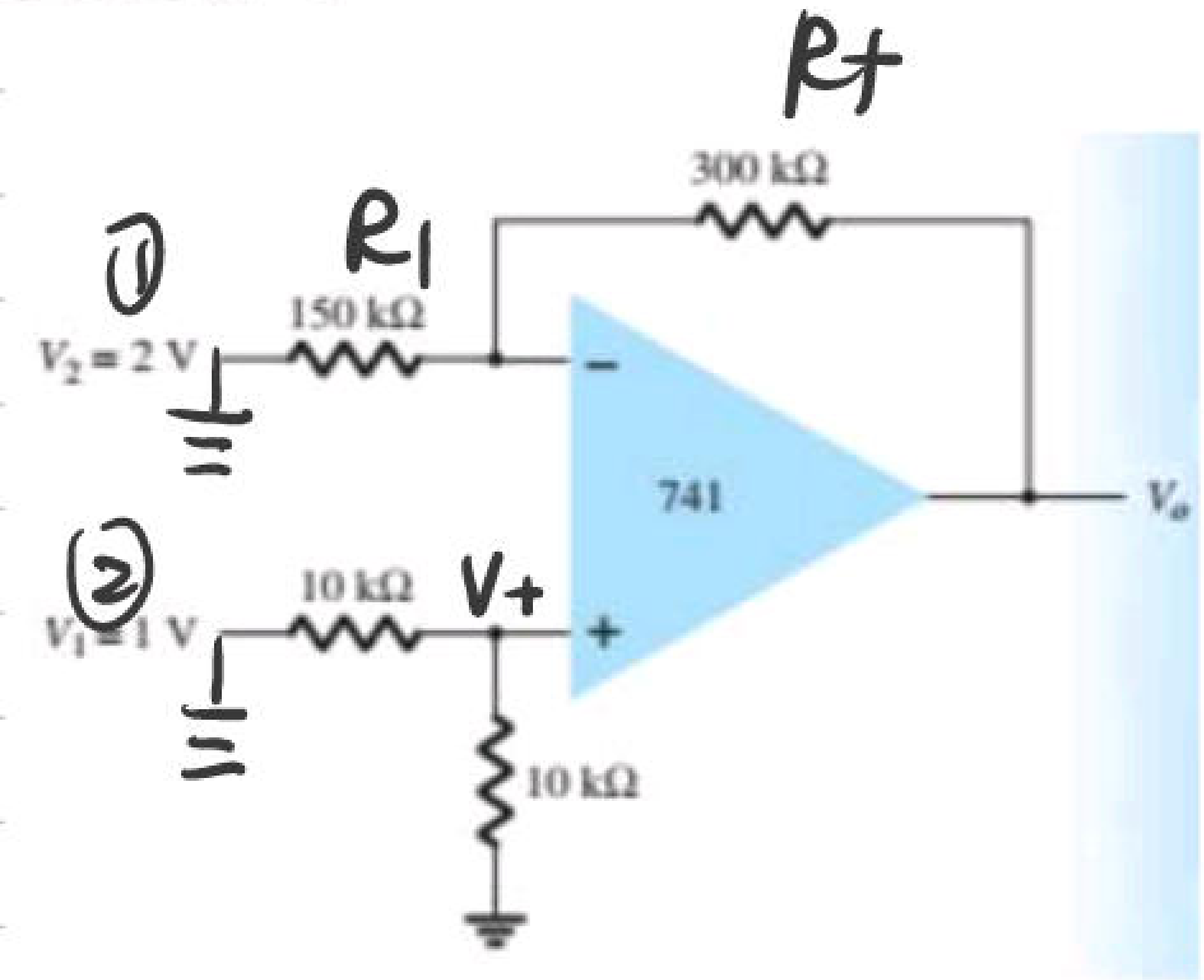
$$= -0.6V$$

$$\Rightarrow \quad V_o = -\left(\frac{300k}{30k} \times -600mV + \frac{300k}{15k} \times -20mV\right)$$

$$= -(-6000mV - 400mV)$$

$$= 6.4V$$

Determine the output voltage for the circuit below .



solution: use superposition

① $V_+ = \frac{10K}{10K+10K} \times V_1$

$= 0.5V$

$V_o' = (1 + \frac{R_f}{R_1}) V_+$

$= (1 + \frac{300K}{150K}) \times 0.5$

$= 1.5 V$

② $V_o'' = -\frac{R_f}{R_1} V_2 = -\frac{300K}{150K} \times 2 = -4 V$

$\therefore V_o = V_o' + V_o'' = -2.5V$