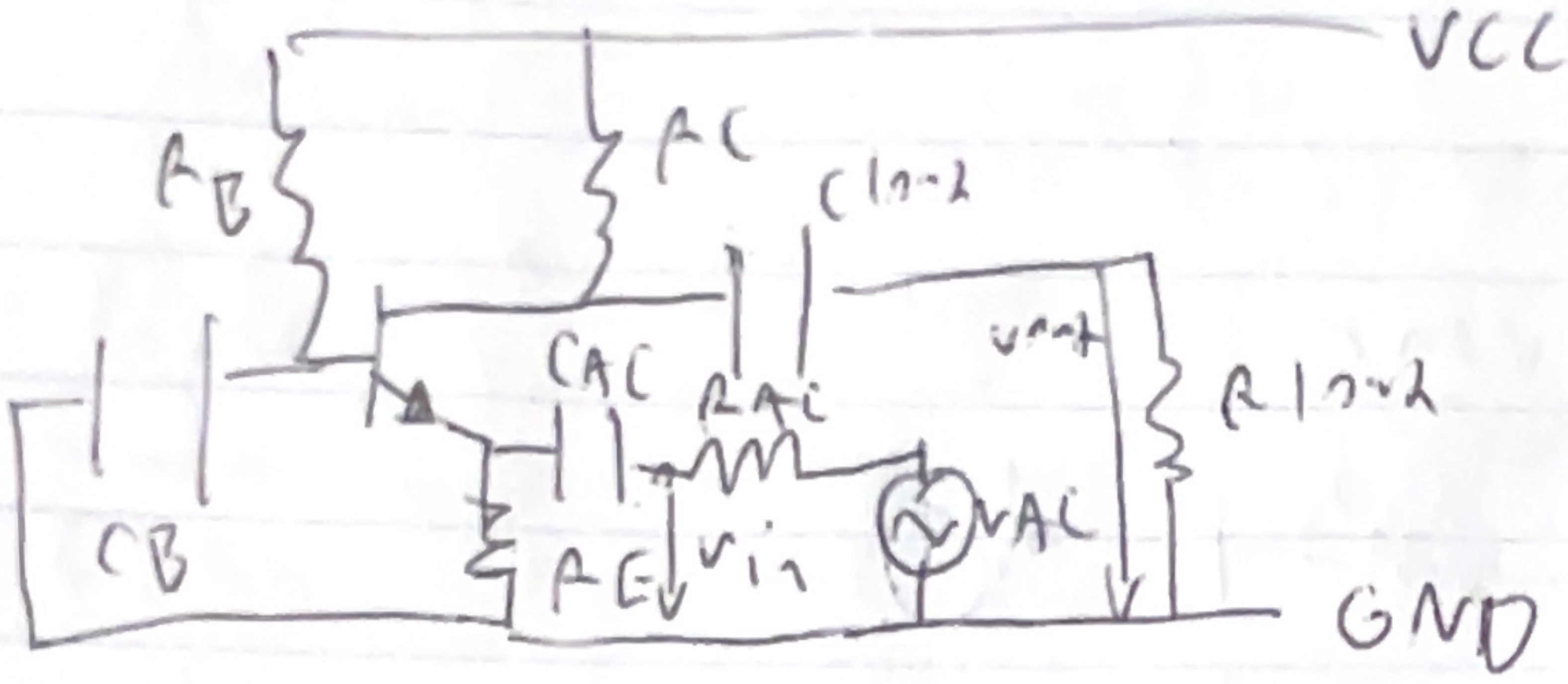
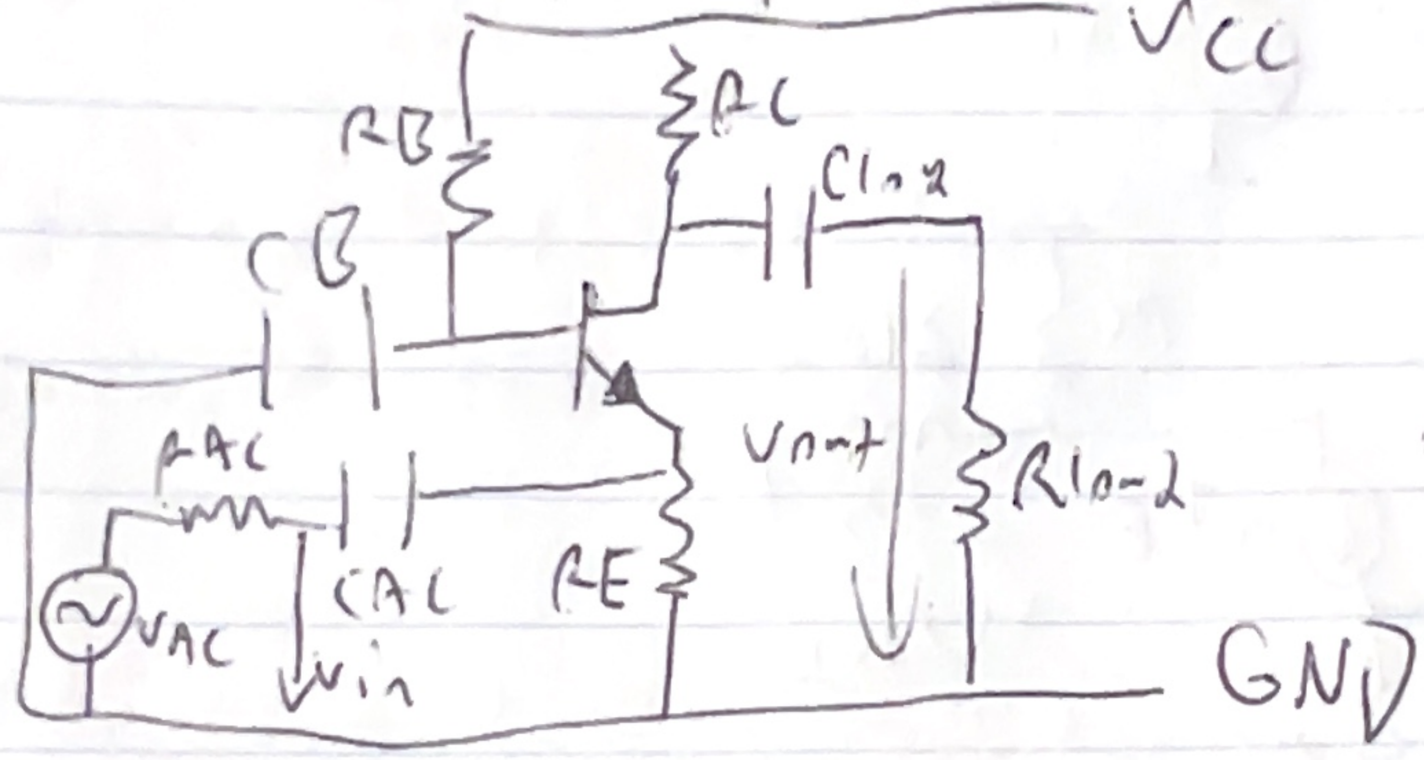
1 $V_{CC} = 12V$ $a = 0.99$ $R_{AC} = 1k$ $R_{load} = 100$



1a β, beta. $\beta = \frac{a}{1-a} = \frac{0.99}{1-0.99} = 99$

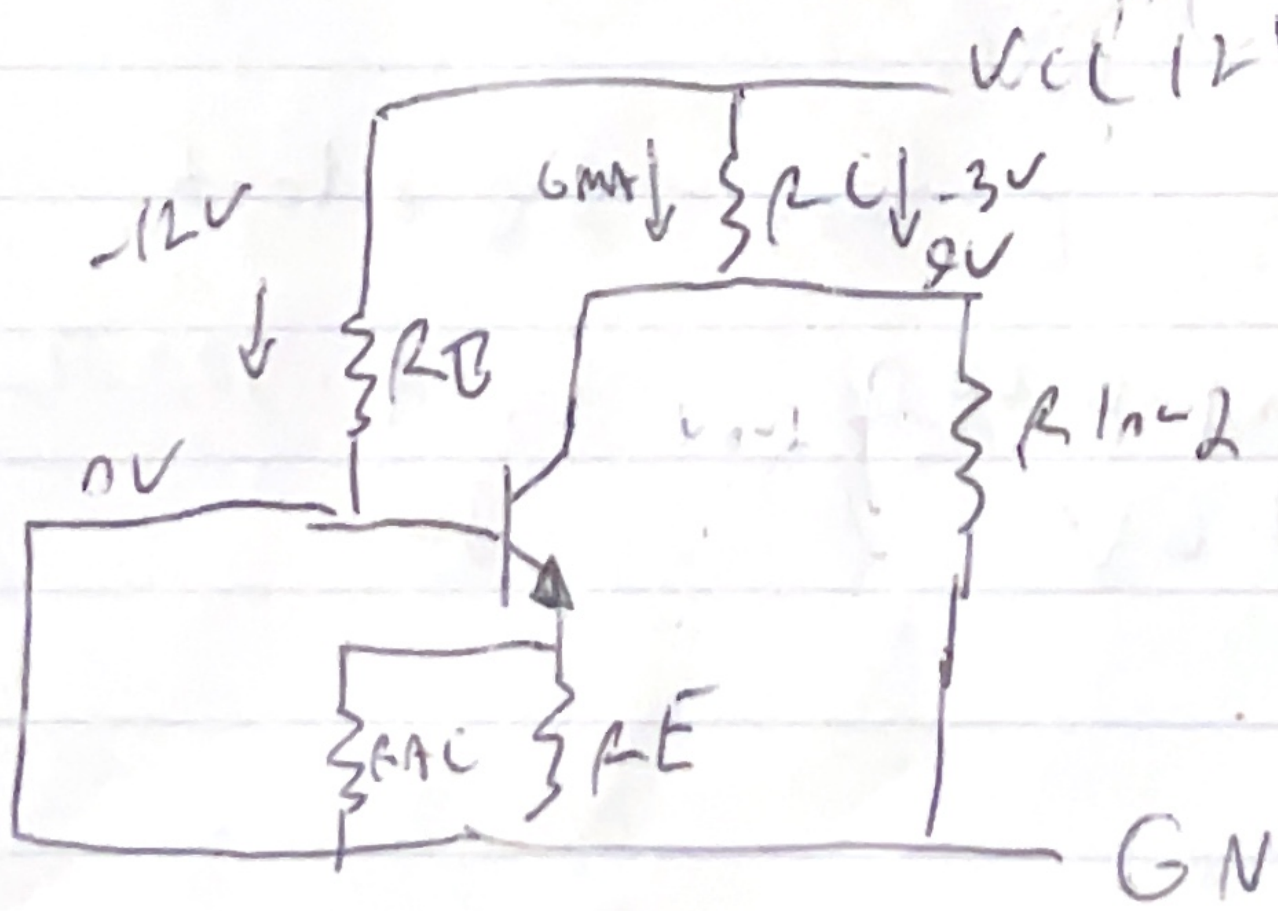
1b



1c both v_{in} and v_{out} are grounded, and GND connects with base side of the transistor (through a DC blocking capacitor). Since base is grounded, input is through emitter, and output is through collector, this circuit is in common base form.

1d $R_C = R_E = 500\Omega$ $V_{RC} = 3V$ $I_E, I_C, I_B, R_B = ?$

$I_E = I_C + I_B$ $I_C = aI_E$



$R_C = 500\Omega$ $I_{RC} = 6mA$

$I_E = \frac{I_C}{a}$

$I_C = 6mA$

$I_E = 6.06mA$

$I_B = 0.06mA$

$V_{RB} = 12V$

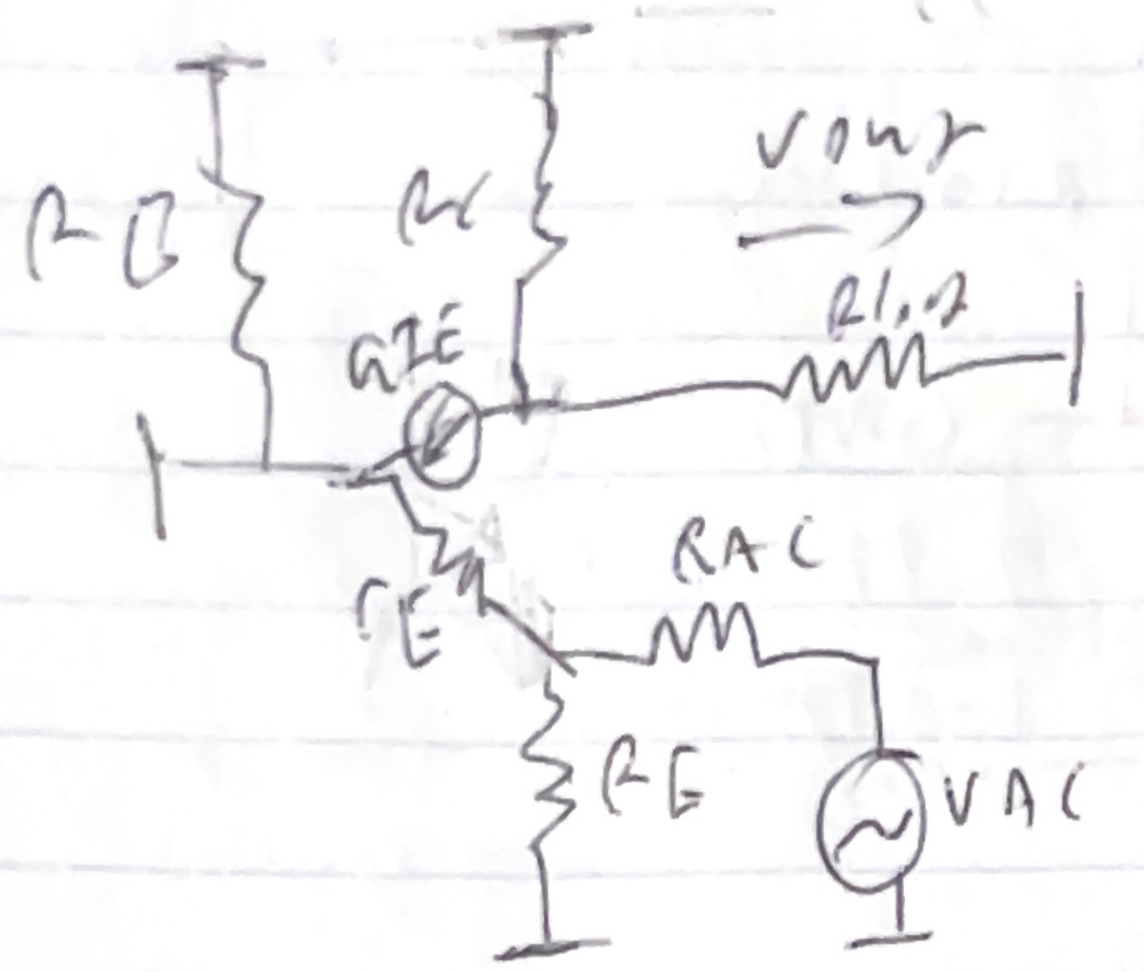
$I_{RB} = I_B = 0.06mA$

$R_B = 200k\Omega$

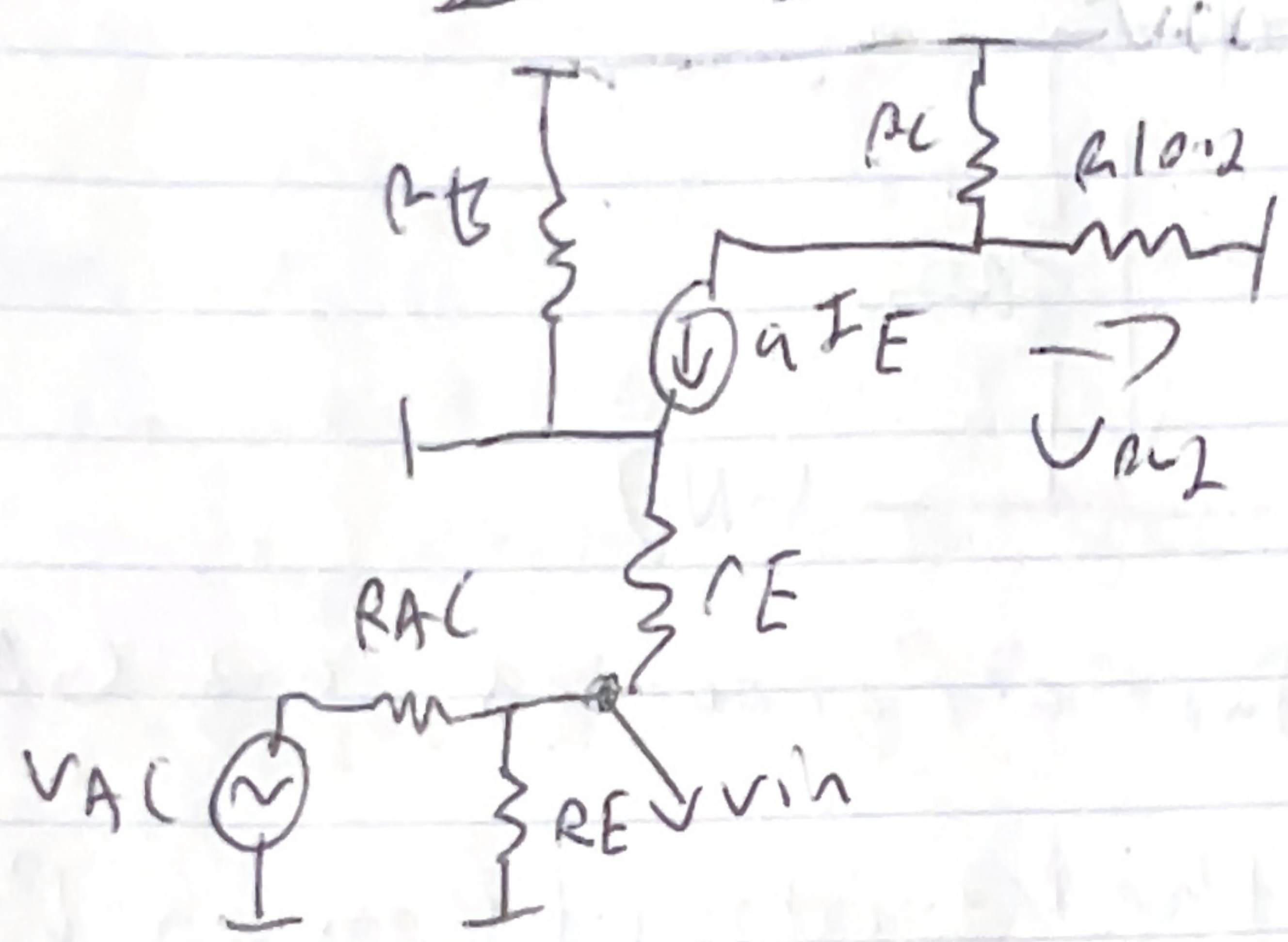
$\frac{V}{I} = R$

1e $r_E = \frac{V_T}{I_E}$ $V_T = 26mV$ $I_E = 6.06mA$ $r_E = 4.29\,\Omega$

1f



1g



1h $Z_{in} = r_E = 4.29\,\Omega$. Relatively low.

1i $Z_{out} = \frac{V_{out}}{I_{out}} = \frac{V_{out}}{\alpha I_E} = \frac{V_{out}}{I_E} = \frac{V_{Rload}}{I_E} = \frac{I_{Rload}\,R_{load}}{I_E}$

$\frac{I_C\,R_{load}}{I_E} = \frac{6 \cdot 10^{-3} \cdot 500}{6.06 \cdot 10^{-3}} = 495\,\Omega$

1j $A_{VAC} = \frac{V_{out}}{v_{in}}$ $v_{in} = I_E r_E$, $V_{out} = I_C R_{load}$

$6.06mA \cdot 4.29\,\Omega$ $6mA \cdot 500\,\Omega$

$A_{VAC} = \frac{3}{0.026} = 115$ $0.026V$ $3V$

$I_C = \alpha I_E$

1k $A_{ISC} = \frac{I_{out}}{I_{in}} = \frac{I_C}{I_E} = \alpha = 0.49$

1l $A_{VOC} = \frac{v_{out}}{v_{in}} = \frac{I R_{load} \cdot R_{load}}{I_E \cdot R_E} = \frac{I_C \cdot \frac{R_{load}}{R_C + R_{load}} \cdot R_{load}}{I_E \cdot R_E}$

$$\frac{6mA \cdot \frac{500}{500+500} \cdot 500}{6.06mA \cdot 500} = 0.495$$

1m $A_{ISC} = \frac{I_{out}}{I_{in}} = \frac{I_C \cdot \frac{R_{load}}{R_C + R_{load}}}{I_E} = \frac{6mA \cdot \frac{500}{500+500}}{6.06mA} = 0.495$

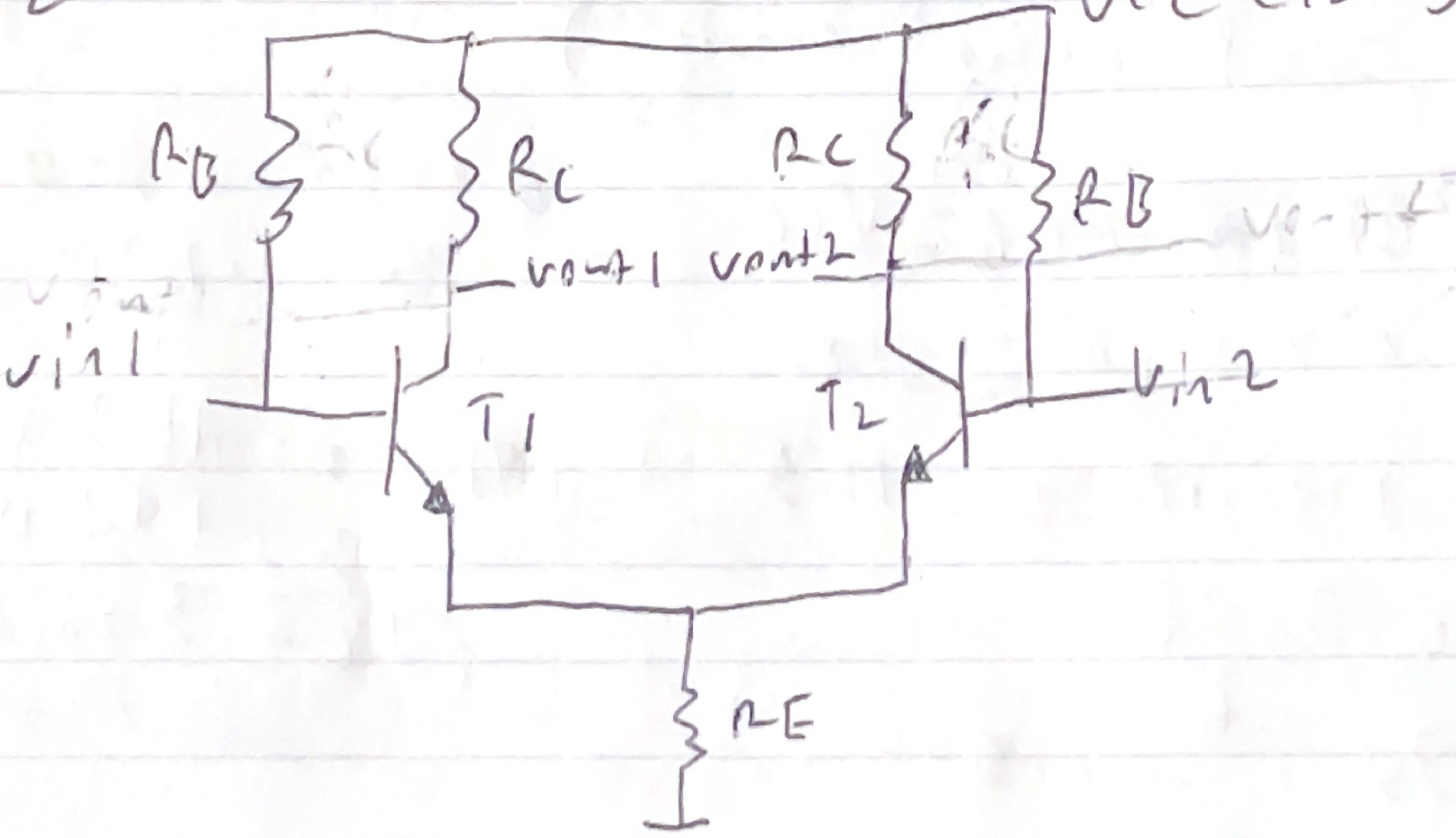
1n It is a high frequency pass filter. The cutoff frequency would be $\frac{1}{2\pi RC}$ where $R = R_{load}$ and $C = C_{load}$

1o $1000 = \frac{1}{2\pi RC}$ $2000\pi = \frac{1}{500C}$ $1000000\pi = \frac{1}{C}$

$C = \frac{1}{1000000\pi}$ $C = 3.183 \cdot 10^{-7}$ F or 0.3183 μF

2.

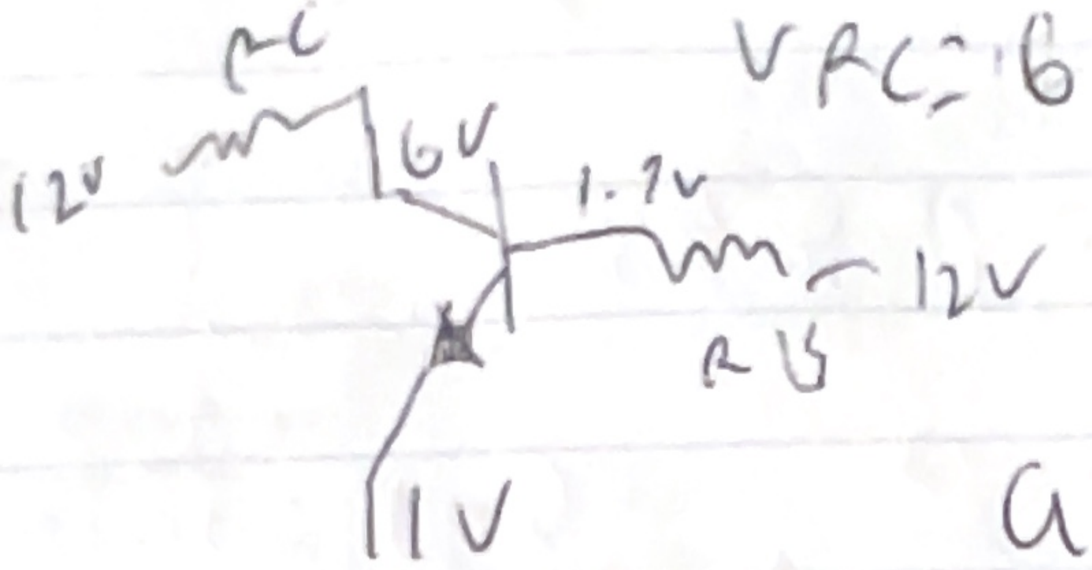
2a



Q point $\beta = 100$

2b $I_{RE} = 20mA$, $V_{RE} = 1V$, $V_{CE} = 5V$ $R_E, R_C, R_B = ?$

$R_E = \frac{V_{RE}}{I_{RE}} = 50\,\Omega$ if VCC 12V and VCE 5V then



$V_{RC} = 6V$ and if $V_{BE} = 0.7V$ then

$V_{RB} = 10.3V$

$\alpha I_E = I_C = \beta I_B$ $\beta = 100$

$\frac{\alpha}{1-\alpha} = \beta$ $\frac{\alpha}{1-\alpha} = 100$ $\alpha \approx 0.99$

$\frac{I_{RE}}{2} = I_E = 10mA$ $I_C = 0.99 \cdot 10mA = 9.9mA$

$I_B = \frac{9.9mA}{100} = 99\mu A$

$I_C = I_{RC}$ $I_B = I_{RB}$

$R_C = \frac{V_{RC}}{I_{RC}} = \frac{6}{9.9 \cdot 10^{-3}} = 606$ ohms

$R_B = \frac{V_{RB}}{I_{RB}} = \frac{10.3}{99 \cdot 10^{-6}} = 104k$ ohms

2c $V_E, V_C, V_{CE}, I_C = ?$ (vias "removed")

$I_B R_B + V_{BE} + 2 I_E R_E = V_{CC}$ $0.99 I_E = 100 I_B$

$I_E = 101 I_B$

$I_B \cdot 104k + 0.7 + 100 I_E = 12$

$I_B \cdot 104k + 100 \cdot 101 I_B = 11.3$ $114k\, I_B = 11.3$

$I_B = 99\mu A$

$V_E = 2 I_B \cdot \beta \cdot R_E$ $I_C = 9.9mA$

$V_E = 2 \cdot 99 \cdot 10^{-6} \cdot 100 \cdot 50$

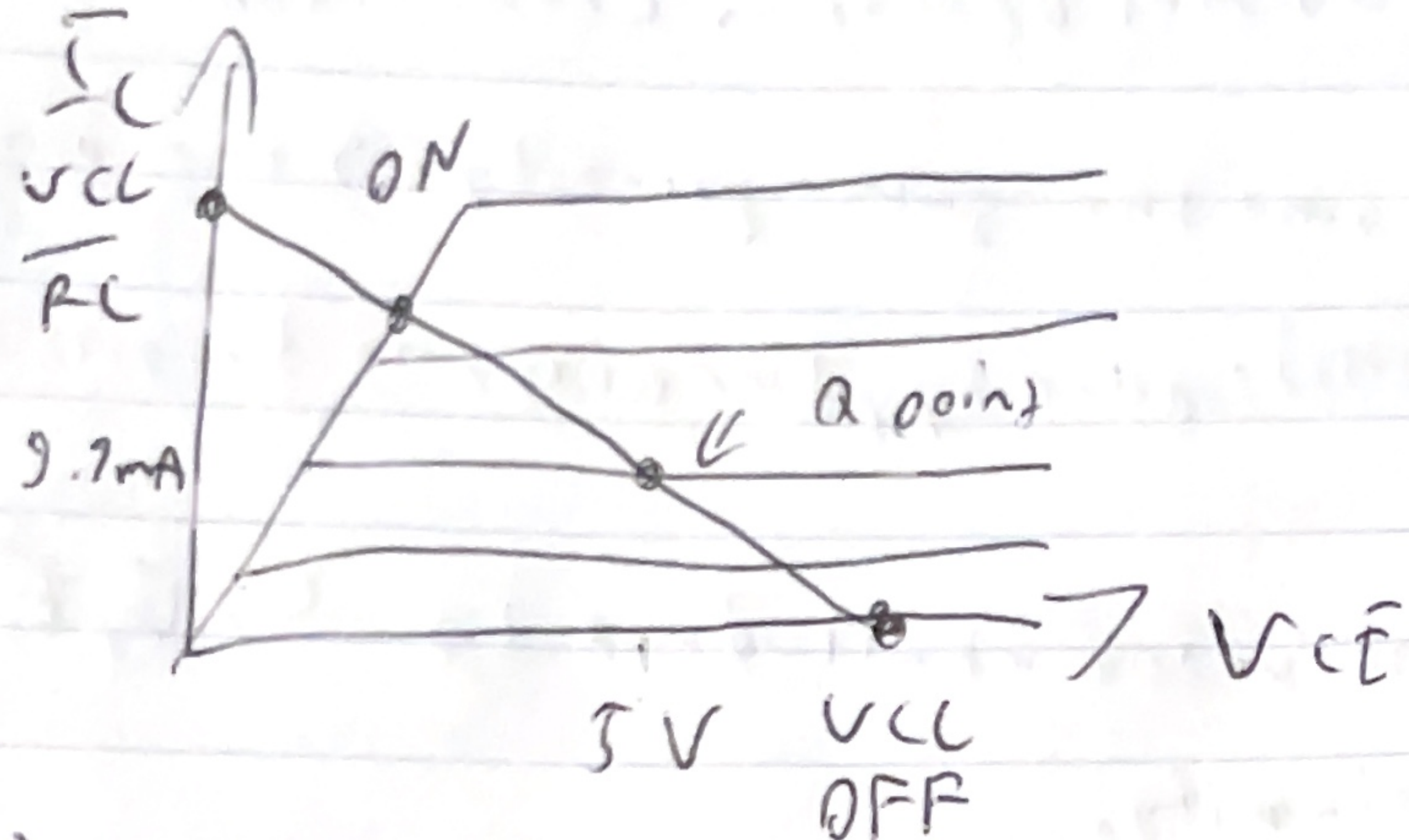
$V_E = 1\,V$?

$V_C = V_{CC} - \beta I_B R_C$

$V_C = 6\,V$? $V_{CE} = V_C - V_E = 5V$?

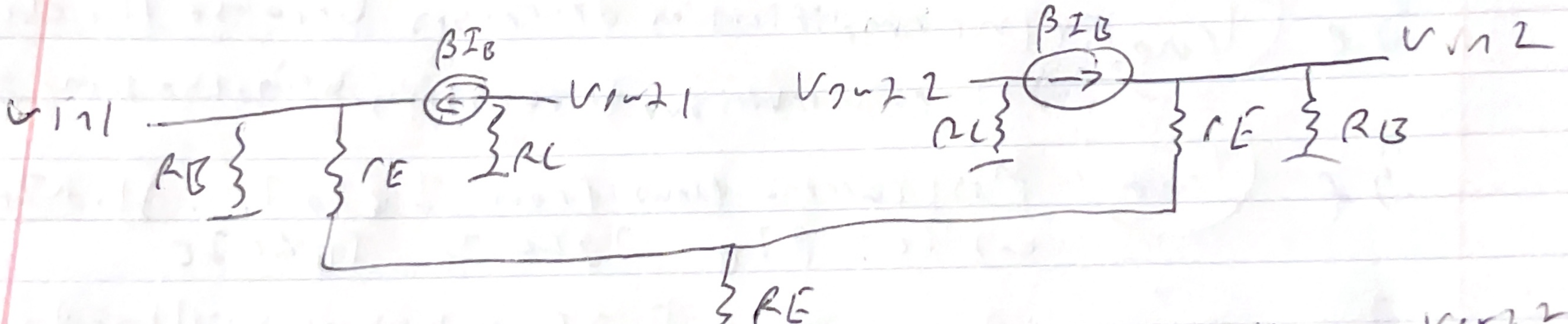
2c cont ~~My VC, VE, and VCE values are utterly wrong... I think its because of my resistor values... don't know how to calculate those correctly~~

Since I_{BE} is constant (due to symmetry of circuit), V_{BE} is constant, which makes V_E constant, or a virtual ground.



2d

$$r_E = \frac{V_T}{I_E} = \frac{26mV}{10mA} = 2.6\,\Omega$$



2e $A_{VDC} = ? = \frac{v_{out}}{v_{in}}$ $\quad v_{in1} = -v_{in2}$ $\quad V_{out} = v_{out1} - v_{out2}$ $= -I_{B_1}$

$$A_{VDC} = \frac{v_{out1} - v_{out2}}{2 v_{in1}} = \frac{\beta I_{B_1} R_C - \beta I_{B_2} R_C}{2 \cdot 2 I_E r_E}$$

$$A_{VDC} = \frac{2\beta I_{B_1} R_C}{4 I_E r_E} \rightarrow \frac{\beta I_B R_C}{2 I_E r_E} \rightarrow \beta I_B \approx I_E$$

$$\frac{R_C}{2 r_E} = A_{VDC}$$

2f $A_{vac} = \frac{R_C}{2r_E} = \frac{6.06}{2 \cdot 2.6} = \underline{116.5}$

2g $A_{vac} \cdot A_{voc} = 116.5 \cdot 116.5 = \underline{13572}$

3a True. $\alpha I_E = I_C$. α is always less than 1, so I_C is always less I_E, in normal operation conditions.

3b True. Base will become the same polarity as the emitter, and collector will be opposite polarity, turning the transistor into a type of diode.

3c False. It will not work at all due to C, B, E all being the same polarity.

3d True. C, B, E will all be the same polarity. It will not work

3e True. The amplification decreases because the circuit stops working due to everything being the same polarity.

3f True. Most current flows from I_C to I_E. Also $\alpha I_E = I_C$ and $I_C = \beta I_B$ $I_B << I_C$ $I_B << I_E$

3g True. Current flows E->C which means voltage drop is positive C->E so going B->C is backwards, or reverse biased.