1

8.

a) The nominal value of β is about 126

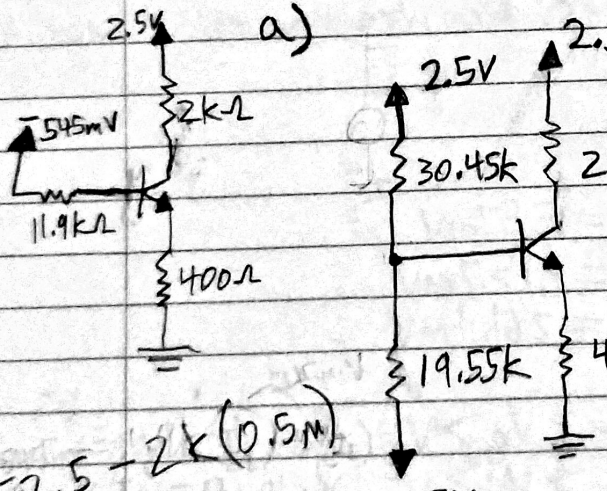
b) The value of RCollector is about 3500Ω. or is it 87?

c) As RC increases, β lowers, causing the transistor to fall into a saturation state.

d) For RC value 1750Ω, $I_C = 650\mu A$

9.

a)



$I_B = 5.194\mu A$ $I_C = 0.5mA$

$V_{BE} = .778$ $\beta = 125$

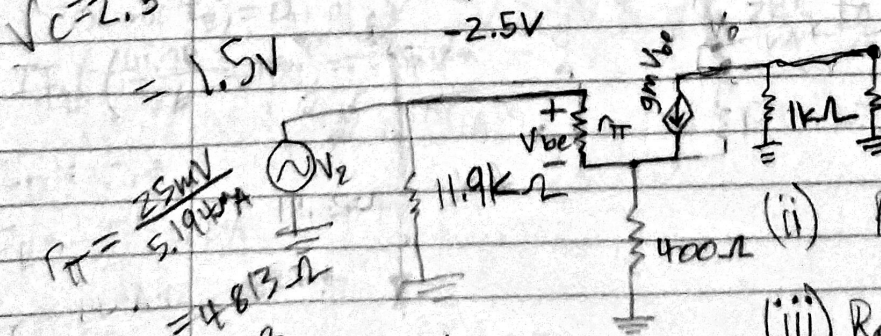
$$V_{Th} = \frac{2.5(19.55k) - 2.5(30.45k)}{19.55k + 30.45k}$$

$V_{Th} = -545mV$

$R_{Th} = 11.9k\Omega$

$V_C = 2.5 - 2k(0.5m)$

$= 1.5V$



$r_\pi = \frac{25mV}{5.194\mu A}$

$r_\pi = 4813\Omega$

$g_m = \frac{\beta}{4813} = 26m$

(ii) $R_{in} = 11.9k\Omega \,||\, (r_\pi + 400(\beta+1))$

$= 9.7k\Omega$

(iii) $R_{out} = 2k\Omega$

(i) $V_0 = 2.5 - 2k(0.5m) = 1.5V$

b)

iii)

Values compared

d)

ii)

C1 effects the starting value for the bandwidth of the circuit. The higher the frequency the longer it takes to reach maximum value.

iii) Trace where -3dB is less than 20 Hz, which I think is 100n.

10.

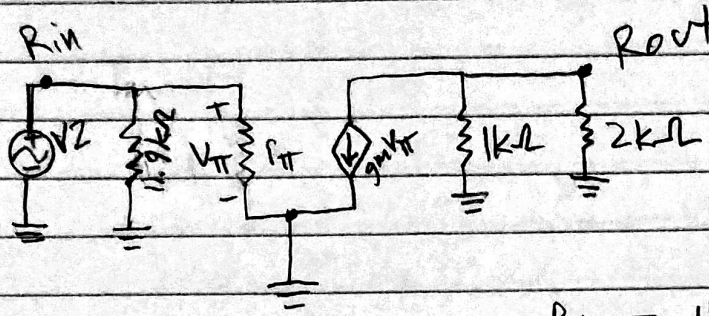
b) The peak value is reached a little faster but it takes longer to fall.

c) Any value with a starting value less than 20 Hz, so the 1pF or 1mF would work just fine

g) The gain is much larger than 1.5V. The capacitors are blocking the DC effect on the biasing of the circuit.

$\beta = 125$

$r_\pi = \frac{25mV}{5.156\mu A} = 4848\Omega$



$V_\pi = .778$

$R_{in} = 11.9k\Omega \,||\, r_\pi = 3445\Omega$

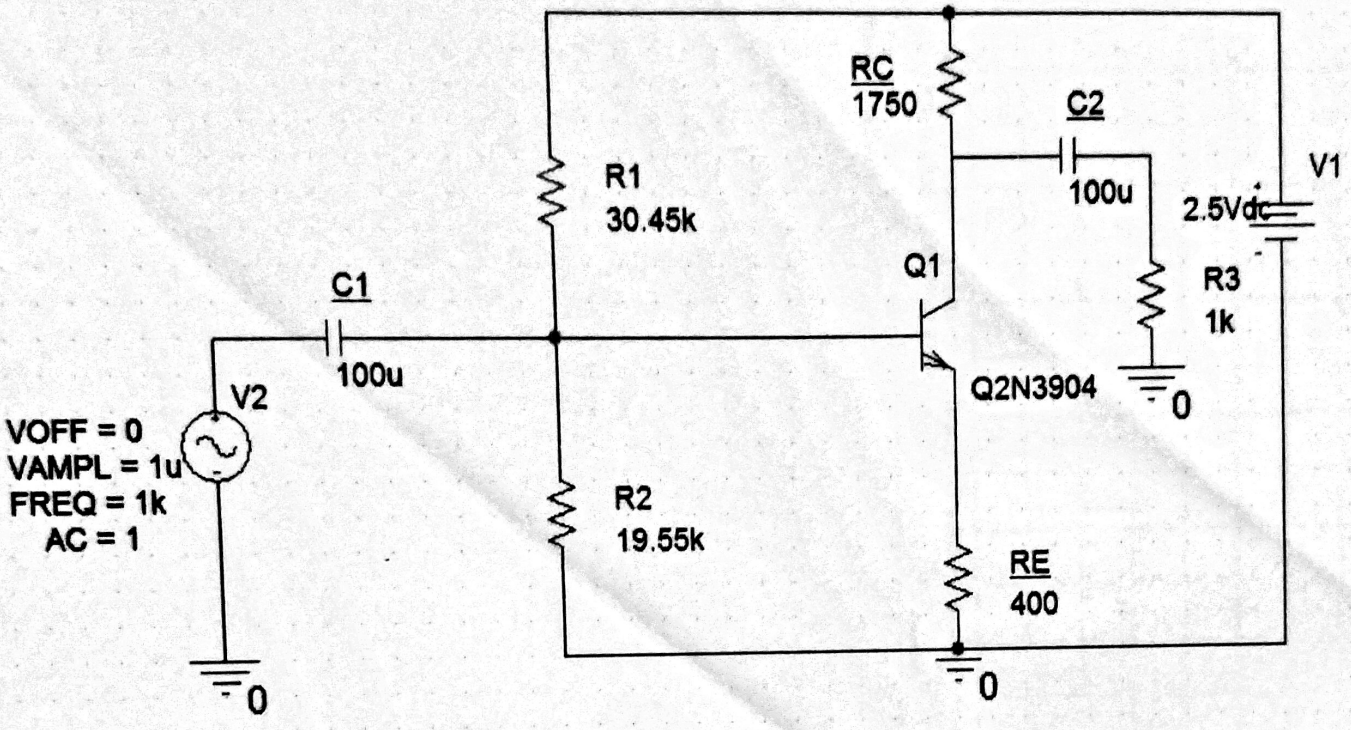
$R_{out} = 2k\Omega$

$g_m = \frac{\beta}{4848} = 26m$

$$\frac{V_o}{V_z} = \left(\frac{(26m)(.778)1k\Omega}{3k}\right) 2k\Omega$$

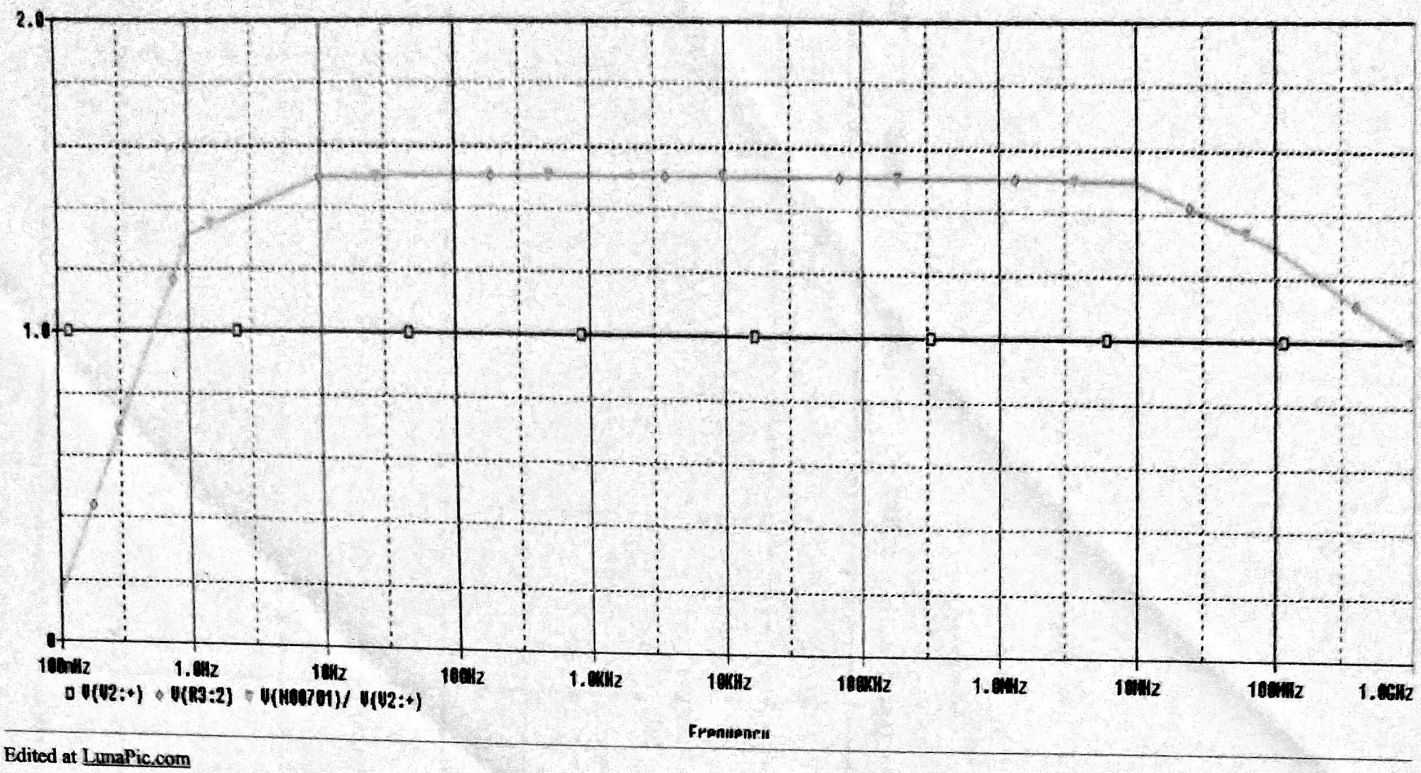
$= 17.3 V/V$

9bi


RC
1750
C2
100u
V1
2.5Vdc
R1
30.45k
Q1
R3
1k
C1
100u
Q2N3904
0
V2
VOFF = 0
VAMPL = 1u
FREQ = 1k
AC = 1
R2
19.55k
RE
400
0
0

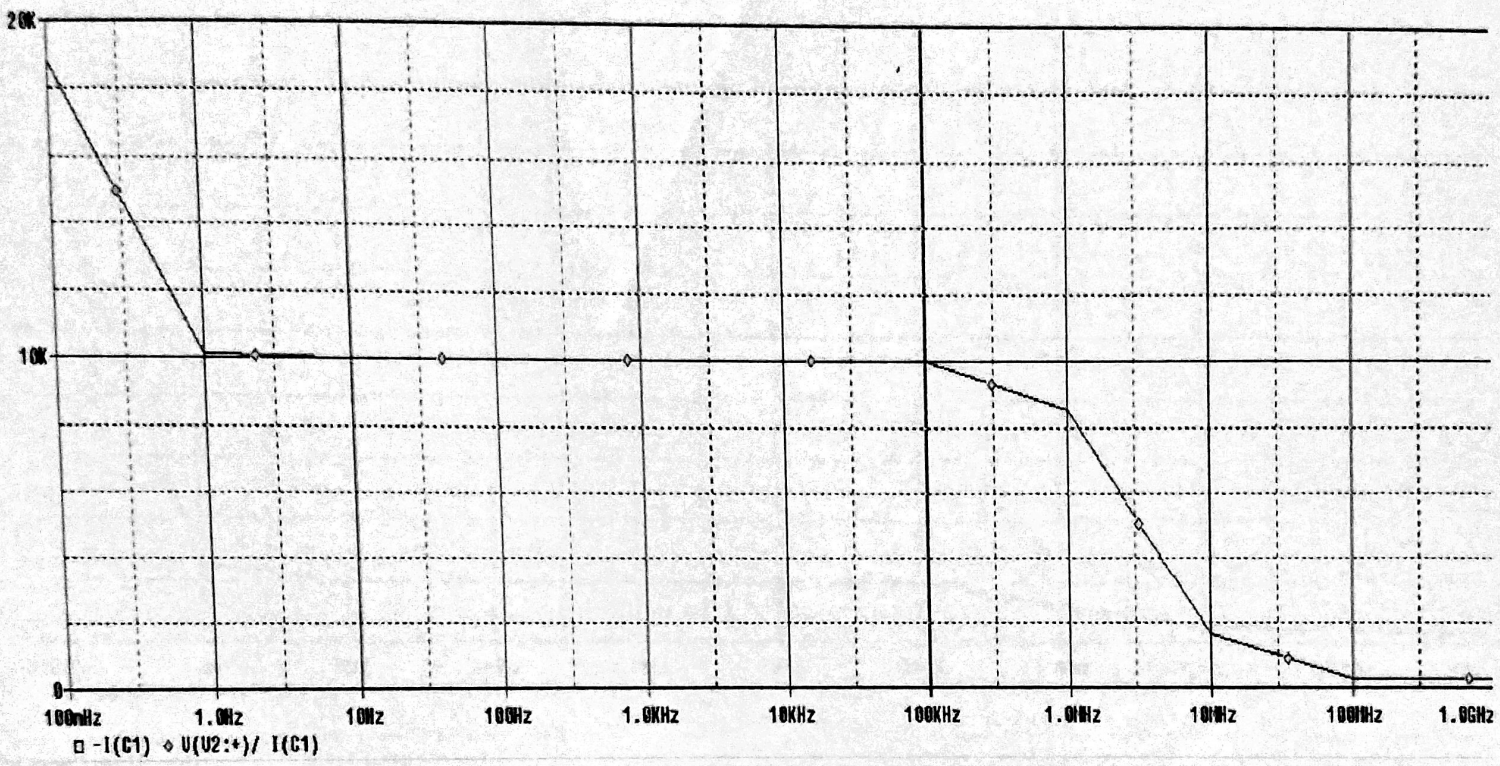
9bii

Printing Photo



2/29/2016 9biv

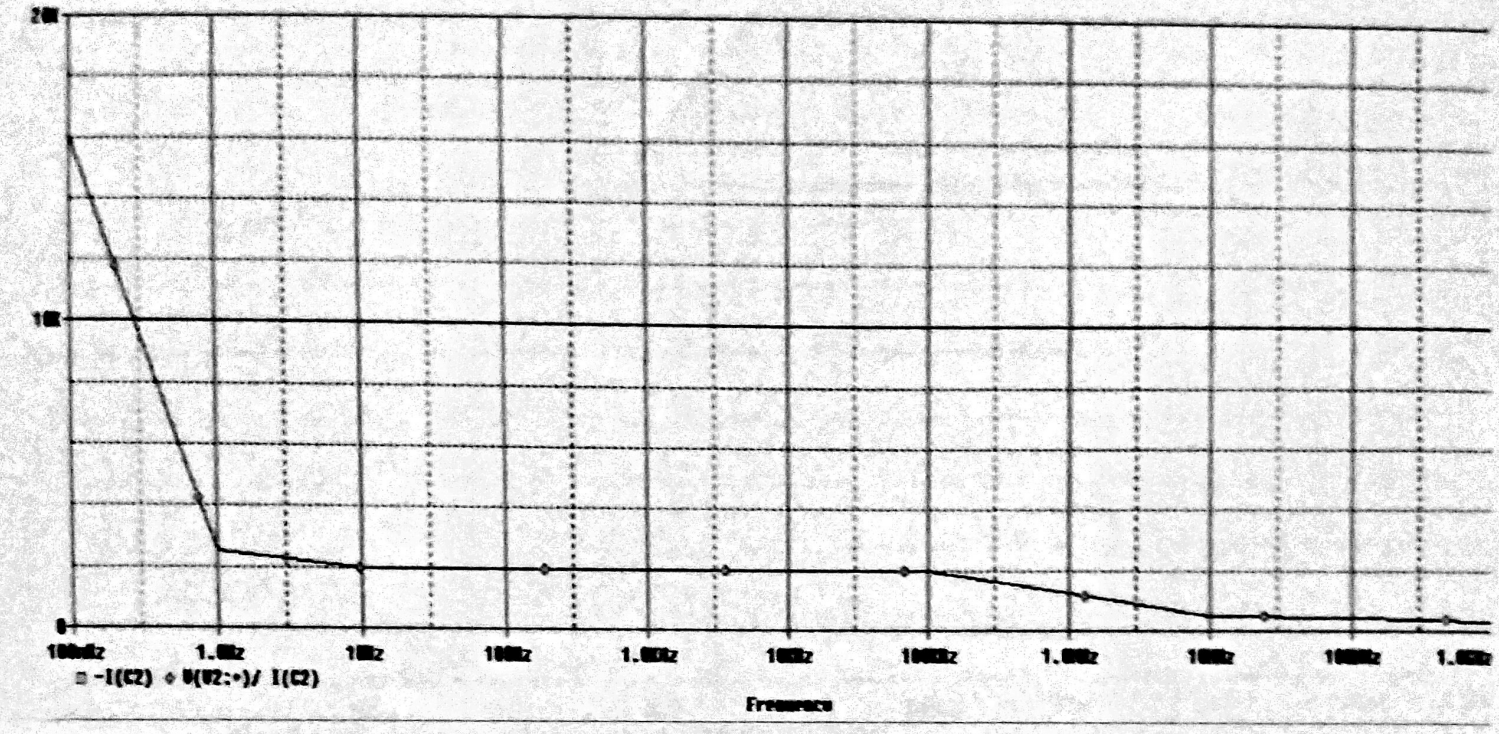
Printing Photo



Rin = 10K so that is right compared to hand analysis.

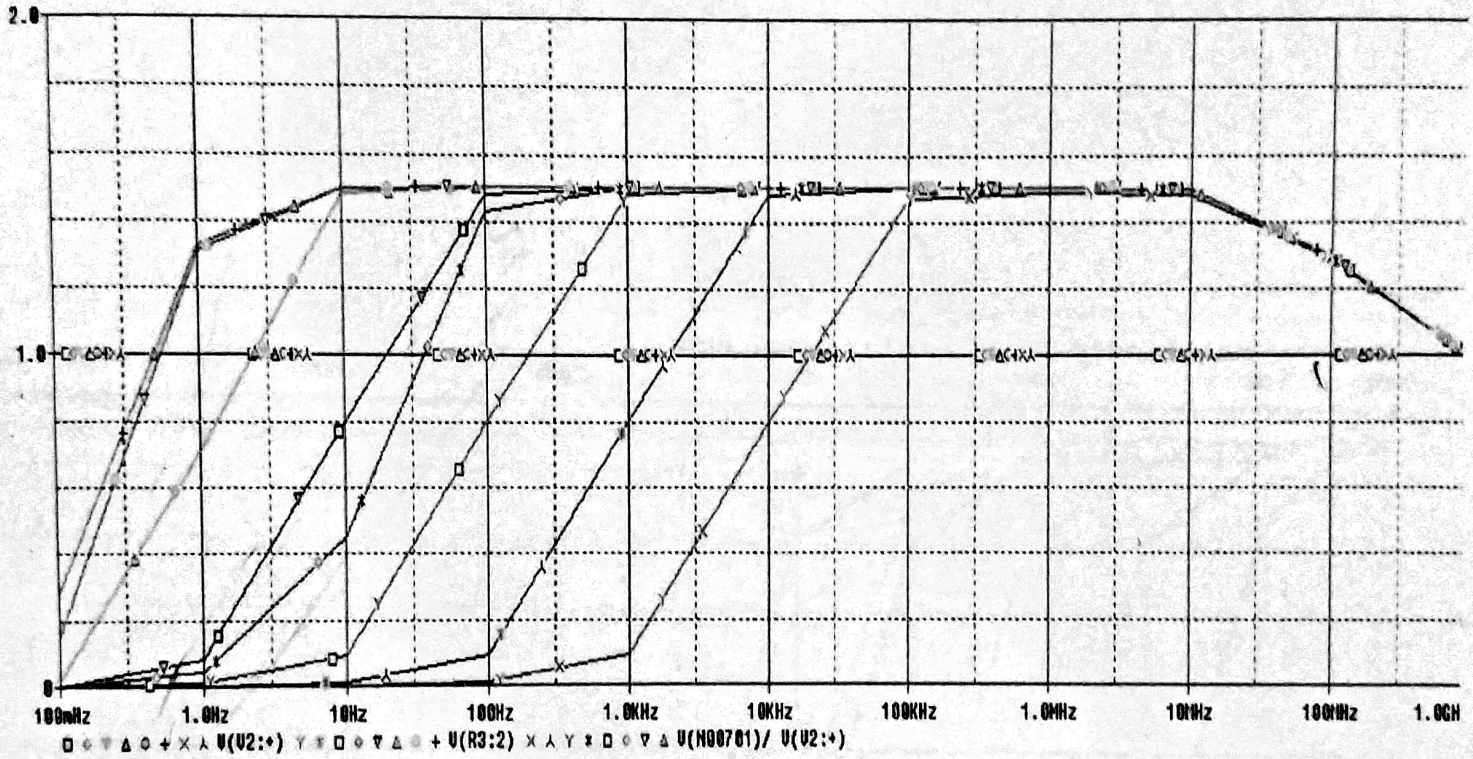
2/29/2016 9 C

Printing Photo

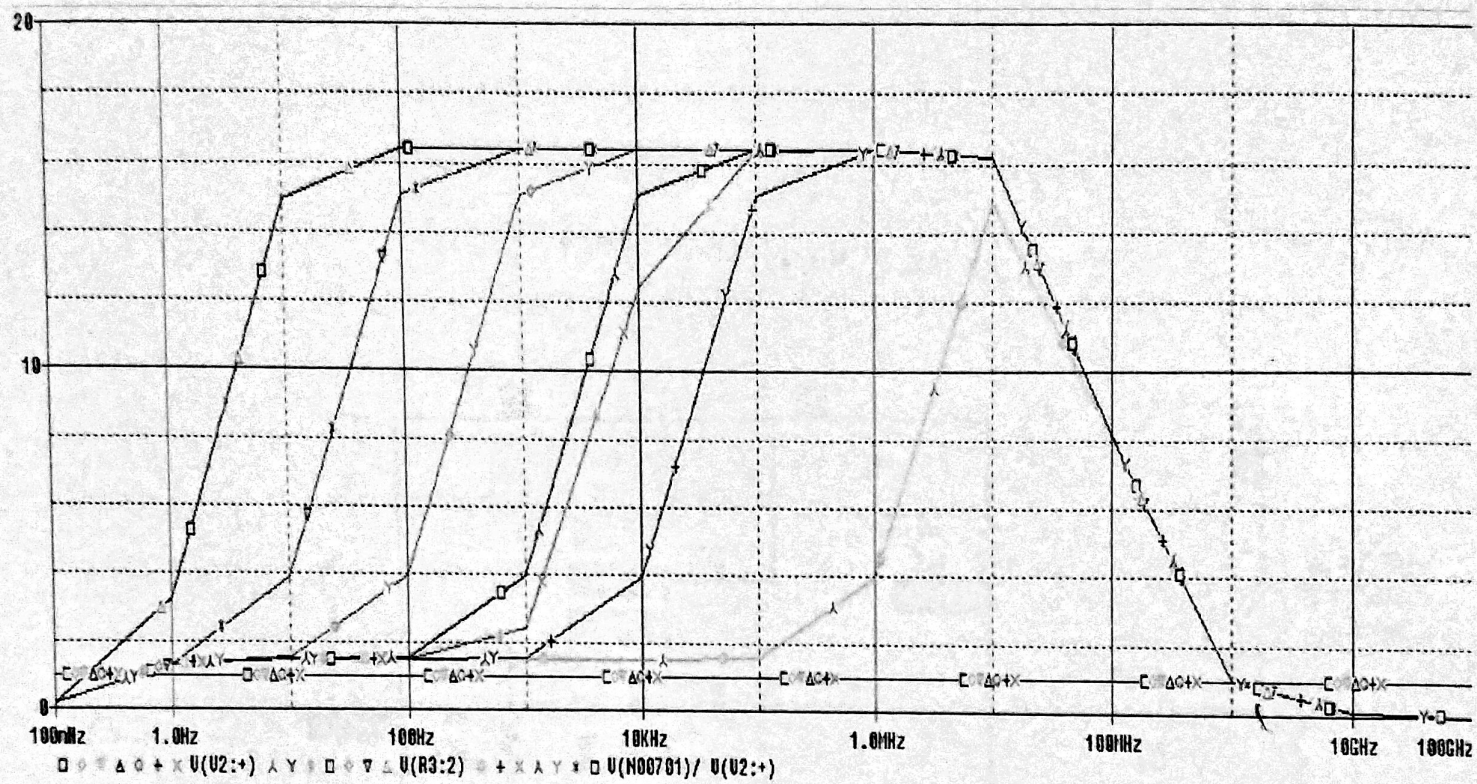


Edited at LunaPic.com

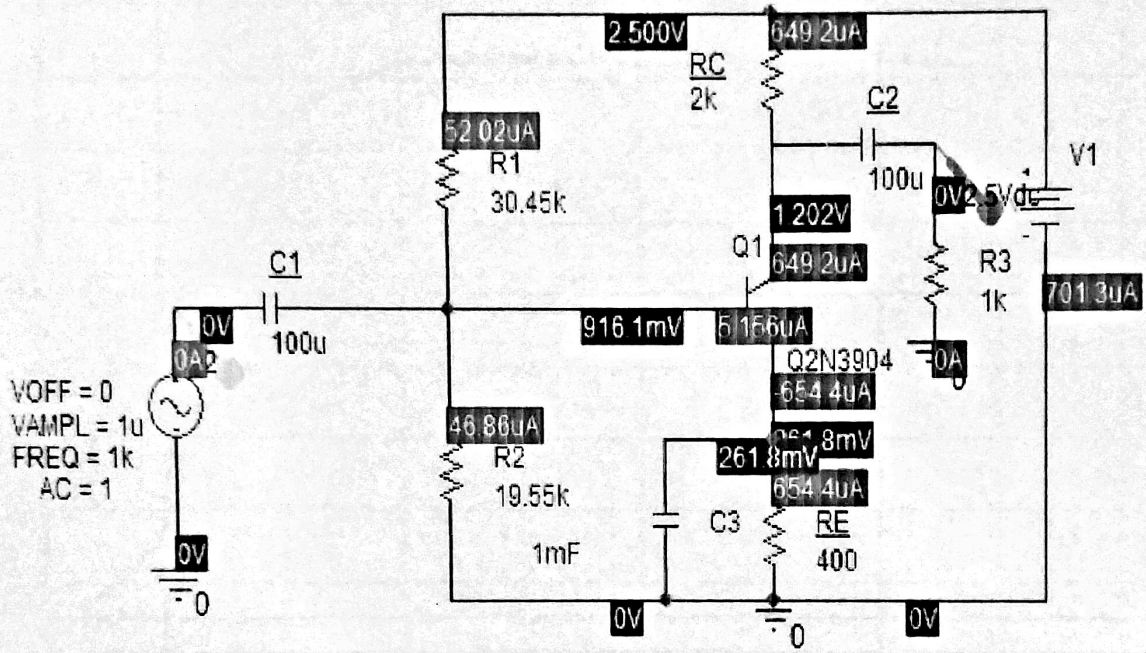
Rout ≈ 2k which is what I had in hand analysis



Edited at LunaPic.com



10e

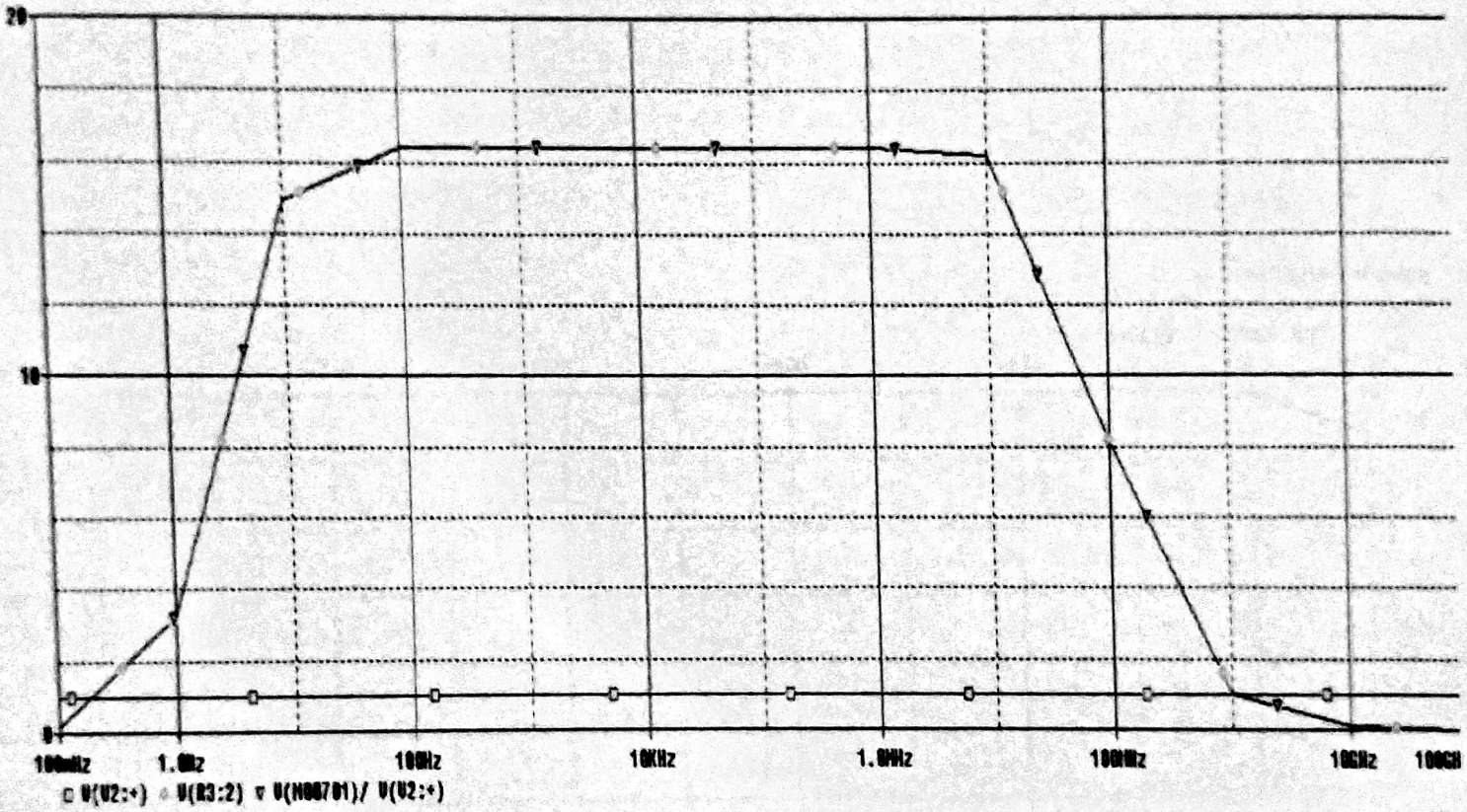


PARAMETERS:

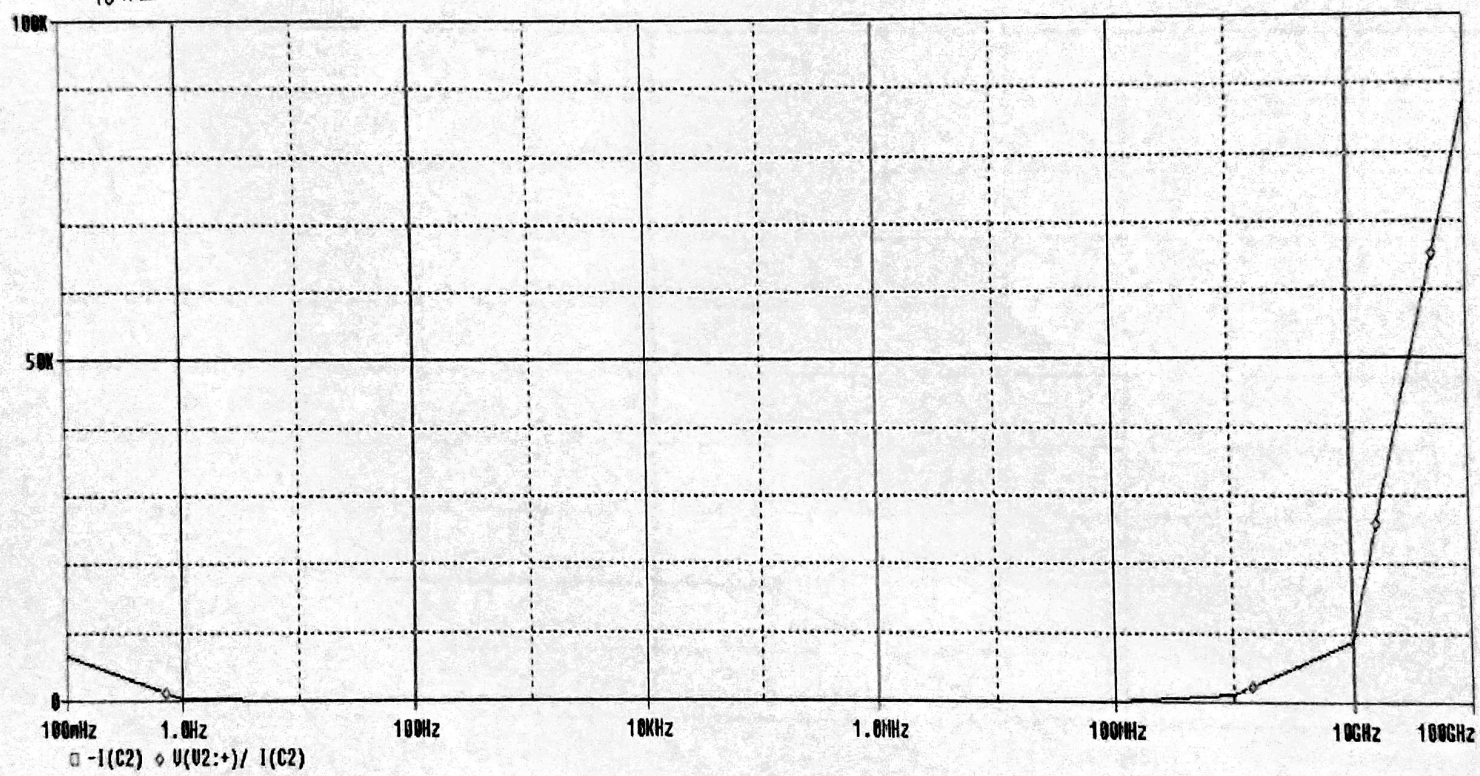
Values are the same

10-

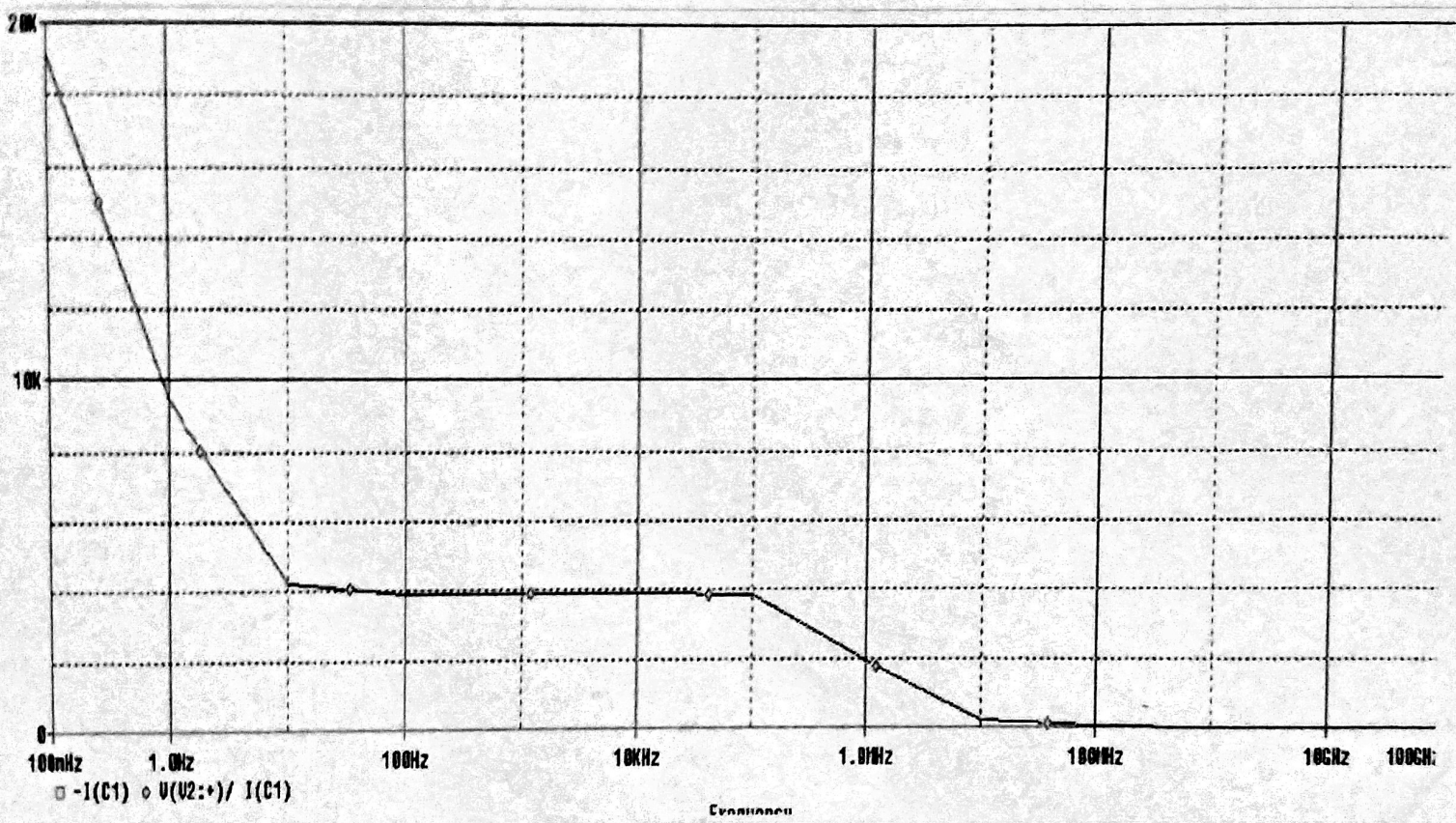
Printing Photo



2/29/2016 10hz Printing Photo

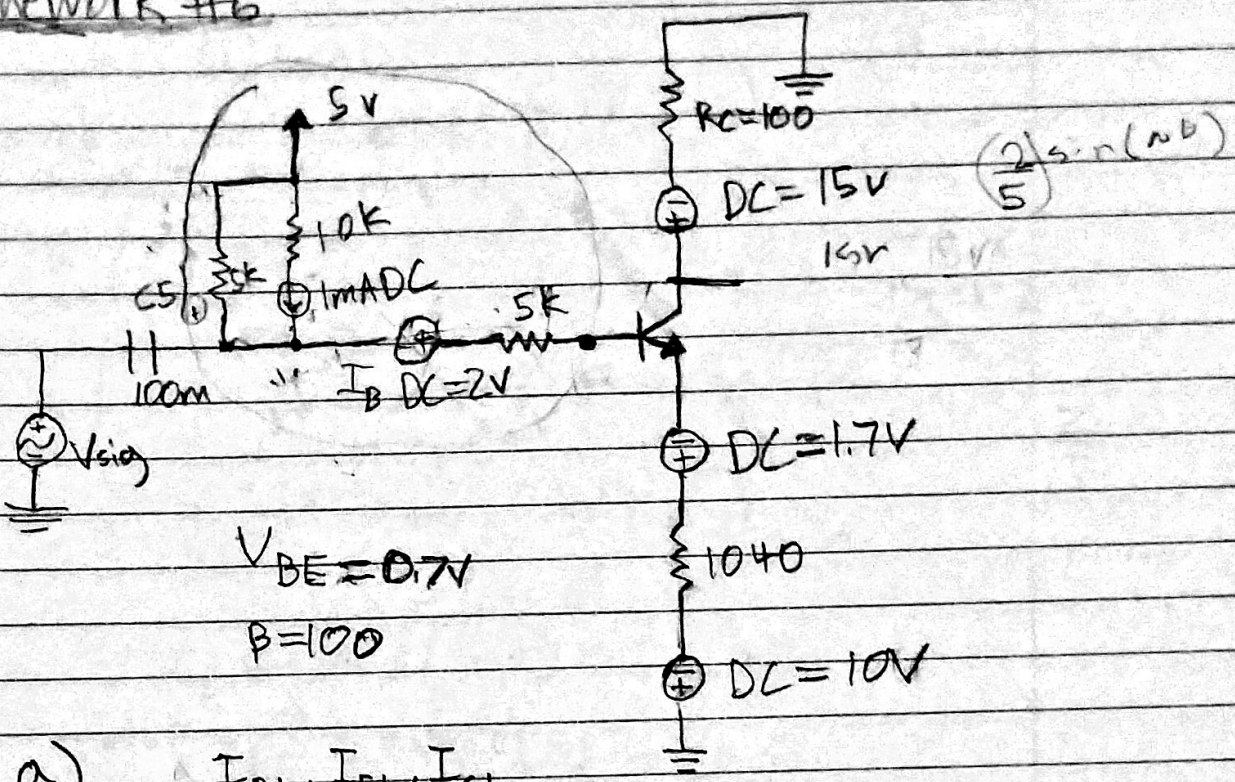


2/29/2016 10h 1 Printing Photo



Nathan Donaldson
ECE 2280

Homework #6

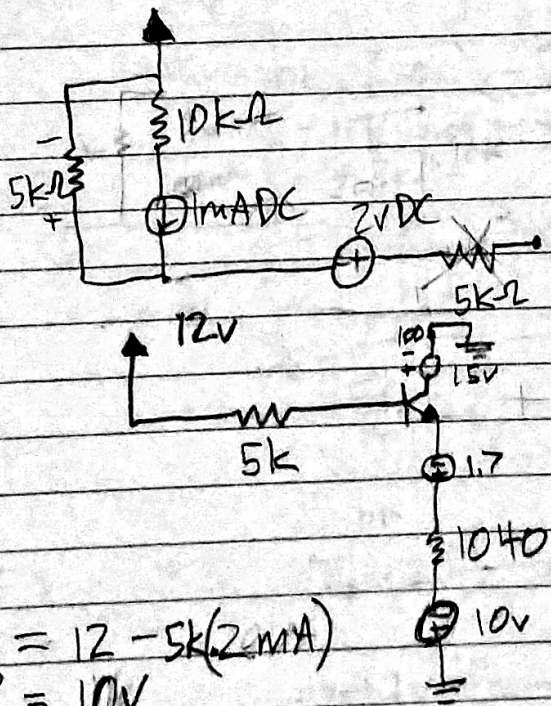


$V_{BE} = 0.7V$

$\beta = 100$

a) I_{B1}, I_{E1}, I_{C1}

V_{B1}, V_{E1}, V_{C1}



$V_{th} = 5 + 5k(1mA) + 2 = 12V$

$R_{th} = 10k\Omega$

$12 - 5k(I_B) - .7 + 1.7 - 1040(I_E) + 10 = 0$

$I_E\left(\frac{-5k}{101} - 1040\right) = -23$

$I_E = 20.2mA$

$I_B = \frac{20.2m}{101} = .2mA$

$I_C = 209\mu A \cdot 100 = 20mA$

$V_B = 12 - 5k(2mA)$
$= 10V$

$V_E = 9.3V$

$V_C = -100(20mA) + 15 = 13V$

b) $V_C \geq V_B > V_E$

$13 \geq 10 > 9.3$ ✓ Active

2.

a) $gain = \frac{V_c}{V_{sig}} = -5 V/V$

$V_C = 13V$

$15 - 13 = 2V$

$V_{sig\,Max} = \frac{2}{5} = 0.4V$

b) $-RC(20mA) + 15 = 10$

$-RC(20mA) = -5$

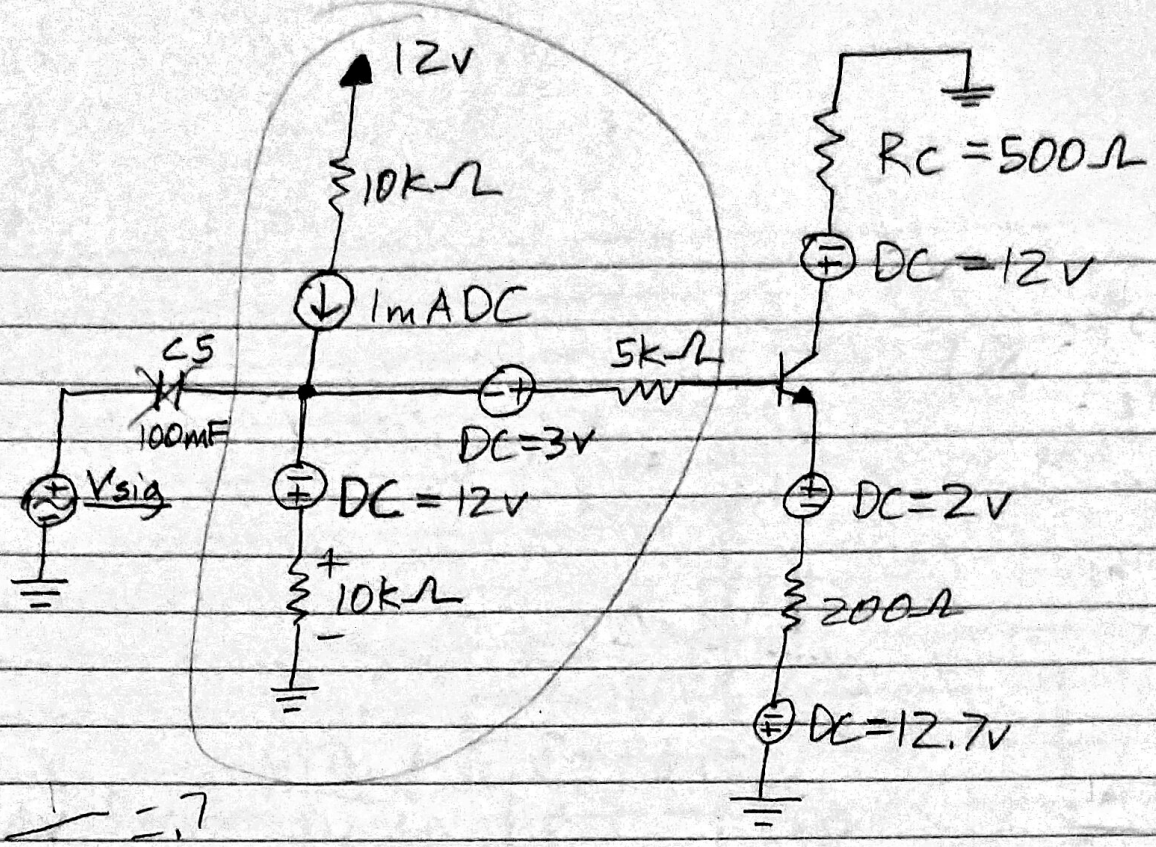
$RC \leq 250\Omega$

3.

$V_{be} = 0.7 \quad \beta = 100$

a)

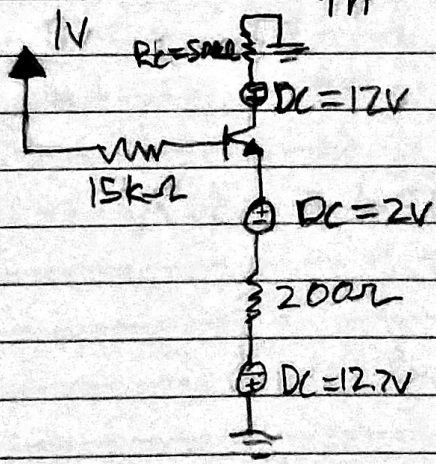
$I_{B1}, I_{E1}, I_{C1}, V_{B1}, V_{E1}, V_{C1}$



$-.7$

$$V_{Th} = 10k\Omega(1mA) - 12V + 3V = 1V$$

$$R_{Th} = 10k + 5k = 15k\Omega$$



$$1V - 15k\Omega(I_B) - 0.7V - 2V - 200\Omega(I_E) + 12.7V = 0$$

$$I_E\left(\frac{-15k\Omega}{101} - 200\Omega\right) = -11V$$

$$I_E = 31.5mA$$

$$I_B = \frac{31.5mA}{101} = .313mA$$

$$V_B = 1V - 15k\Omega(.313mA)$$

$$= -3.7V$$

$$V_E = -3.7 - 0.7V = -4.4V$$

$$I_C = .313mA \cdot 100 = 31.25mA$$

$$V_C = -500\Omega(31.25mA) + 12V = -3.63V$$

b)

$$V_C \geq V_B > V_E \qquad \underline{\text{Active}}$$

$$-3.63 \geq -3.7V > -4.4V \checkmark$$

4.

a)

$$\frac{V_c}{V_{sig}} = -10\ V/V$$

$V_C - V_B$

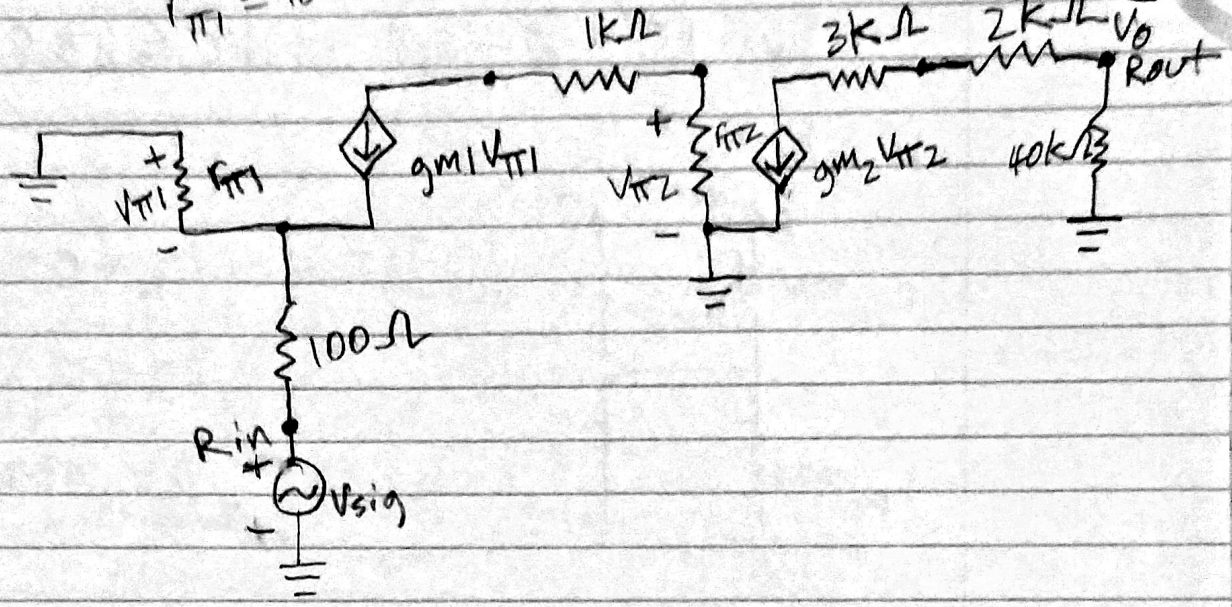
$-3.63 + 3.7 = \frac{.07V}{10} = 7mV$

b)

$-RC(31.25mA) + 12V = -3.7V$

$RC \leq 502.4$

5. $V_T = 25mV$ $r_{\pi 1} = 4000$ $g_{m2} = 4mA/V$



a)
$$R_{in} = 100\Omega + \frac{r_{\pi 1}}{\beta+1} = 140\Omega$$

b) $R_{out} = 40k\Omega$

c) $$V_{\pi_1} = \frac{-V_{sig}(r_{\pi 1})}{100(\beta+1) + r_{\pi 1}}$$

$\frac{\beta}{g_{m2}} = 25K$

$r_{\pi 2}$

$$V_{\pi_1} = -V_{sig}(.28)$$

$$V_{\pi 2} = g_{m_1} V_{\pi 1} (r_{\pi 2})$$

$g_{m_1} = \frac{\beta}{4000} = .025$

$$V_{\pi 2} = -g_{m1}(V_{sig}(.28))(r_{\pi_2})$$

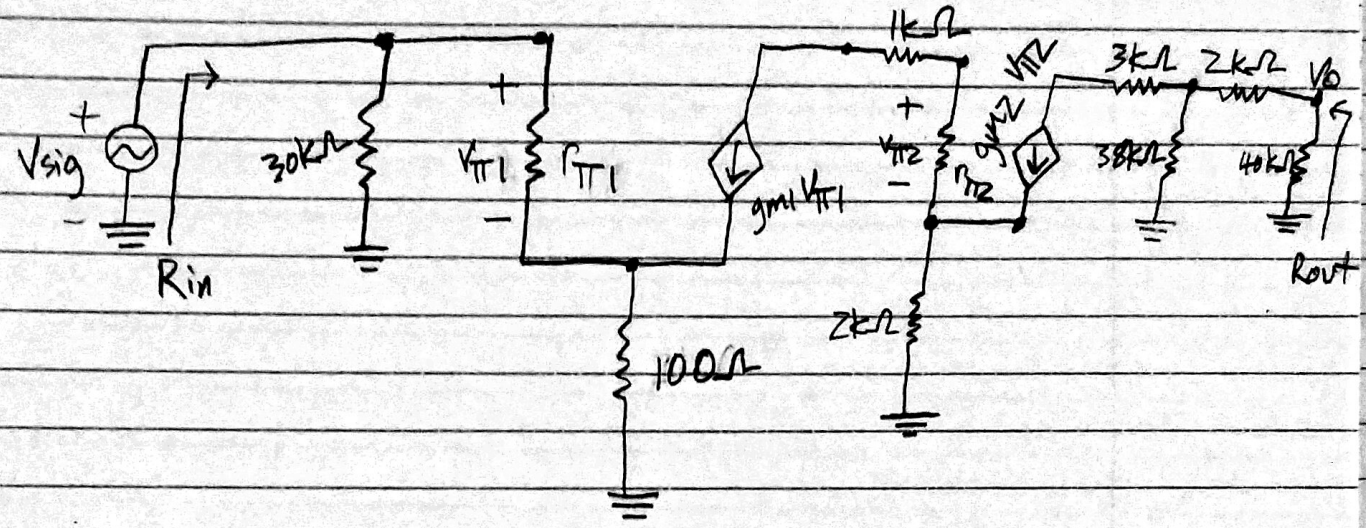
$$V_o = 4mA\left(-(.025(V_{sig}(.28)))(25k)\right)(40k)$$

$$\frac{V_o}{V_{sig}} = -28367$$

e) Rout would decrease in value, depending on value of r_o. But overall, it will decrease.

d) Not ideal, too high for Rout, too low for Rin

6. $g_{m2} = 2mA/V$ $r_{\pi 1} = 2000$ $\beta = 100$



a)
$$R_{in} = 30k\Omega \,||\, (r_{\pi 1} + 100(\beta+1))$$
$$= 8622\,\Omega$$

b) $R_{out} = 40k\Omega \,||\, 40k\Omega = 20k\Omega$

c) $$V_{\pi 1} = \frac{V_{sig}(r_{\pi 1})}{r_{\pi 1} + 100(\beta+1)}$$

$g_{m1} = \frac{\beta}{2k} = .05$

$r_{\pi 2} = \frac{\beta}{g_{m2}} = 50k$

$$V_{\pi 2} = -g_{m1}(V_{sig}(.165))\, r_{\pi 2}$$

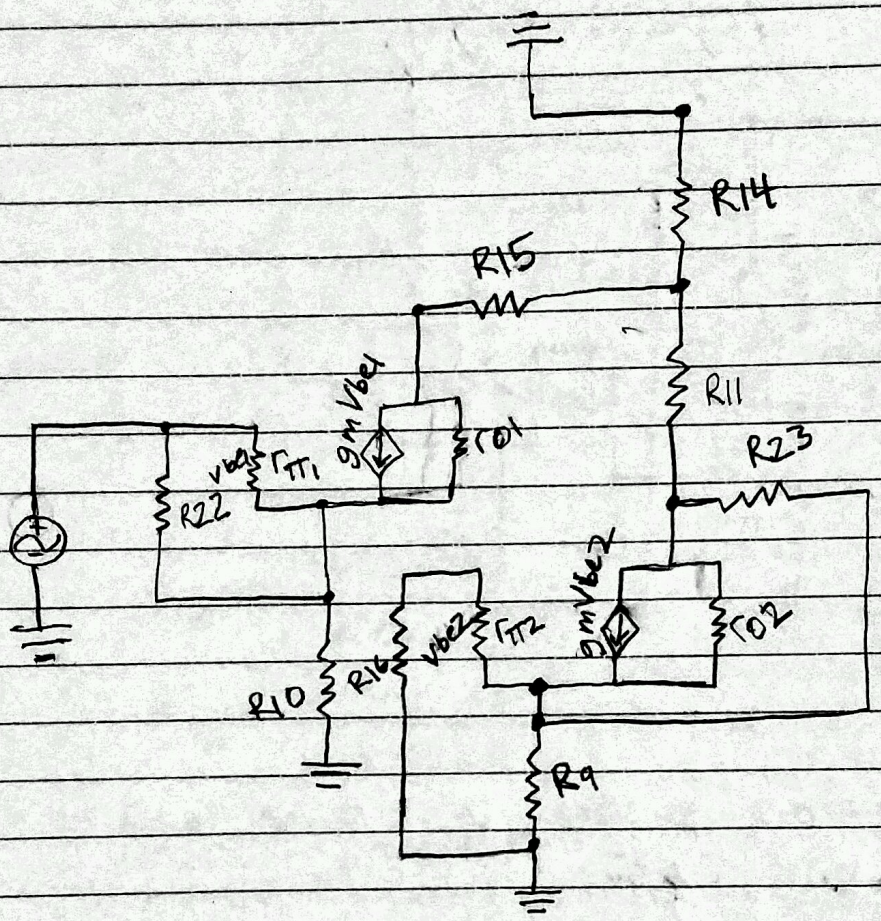
$$V_o = -\frac{((2mA)(-.05)(V_{sig}(.165))(50k))(38k)}{40k+38k+2k}(40k)$$

$$\frac{V_o}{V_{sig}} = 15.7k$$

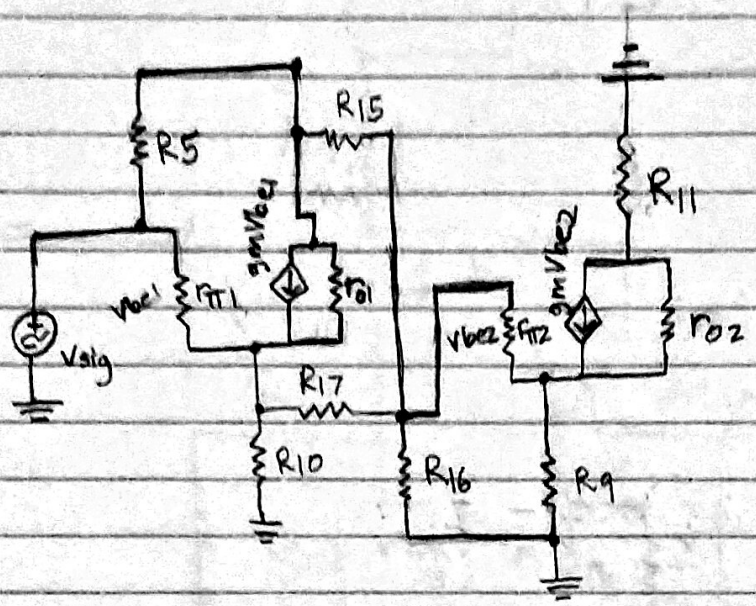
d) Not very ideal, too high of Rout, too low of Rin

e) Rout will decrease in value, depending on value of r_o, but overall it will decrease.

7.

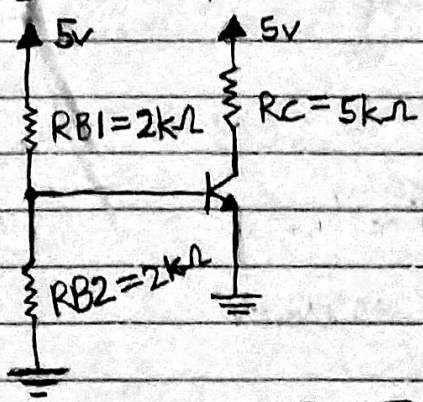

R14
R15
R11
R23
gmVbe1
ro1
vbe1
rπ1
R22
gmVbe2
ro2
vbe2
rπ2
R16
R10
R9

8.



9.

$V_{BE} = 0.7 \quad \beta = 100 \quad V_{CE_{SAT}} = 0.2V$

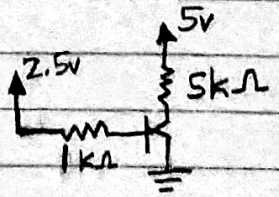


$5v - I_C(5k\Omega) - 0.2 = 0$

$R_{Th} = \frac{(2k\Omega)(2k\Omega)}{2k\Omega + 2k\Omega} = 1k\Omega \quad I_C = 0.96mA$

$\beta_{forced} = \frac{0.96mA}{1.8mA} = .53$

$V_{Th} = \frac{(5v)(2k\Omega)}{4k\Omega} = 2.5V$



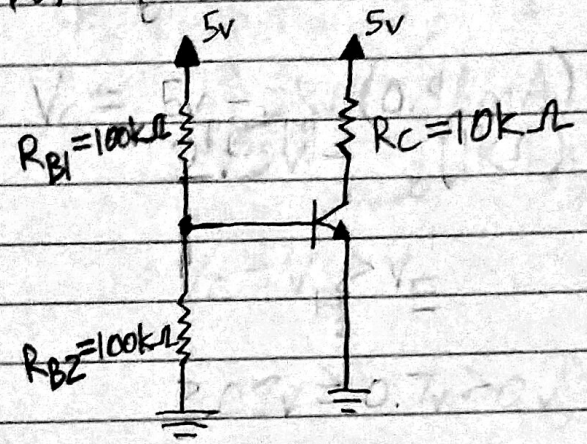
$2.5v - 1k\Omega(I_B) - 0.7 = 0$

$I_B = 1.8mA$

$I_C = I_B \cdot \beta = 180mA$

$5v = RC(180mA) = 0.7 \quad RC \leq 23.8\Omega$

10.



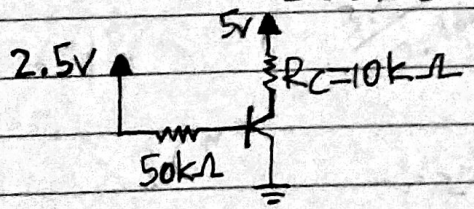
$V_{BE} = 0.7v$

$\beta = 100$

$V_{CE_{SAT}} = 0.2v$

$$V_{Th} = \frac{5v(100k\Omega)}{200k\Omega} = 2.5v$$

$$R_{Th} = \frac{(100k\Omega)(100k\Omega)}{200k\Omega} = 50k\Omega$$



$$\beta_{forced} = \frac{0.48mA}{36\mu A} = 13.33$$

$I_C = I_B \cdot \beta =$

$5v - 10k\Omega(I_C) - 0.2v = 0$

$5v - RC(3.6mA) = .7v$

$V_B = 2.5v - 50k\Omega(36\mu A) \quad I_C = 0.48mA$

$= .7v$

$RC \leq 1194.44\Omega$

$2.5v - 50k\Omega(I_B) - 0.7v = 0$

$V_C = 5v - 10k\Omega(0.48mA)$

$= .2v$

$I_B = 36\mu A$

$V_E = 0v$