Lab #3 BJT Transistors

Nathan Donaldson 2/17/16
ECE2280

Parts

100μF capacitor
0.1μF capacitor

Experiment 1: Transistor Diode Test

a)
Lead 2 is the base

b)
Transistor is a PNP resistor because base is - lead in both cases.

c)
From transistor diagram, the assumptions are correct.

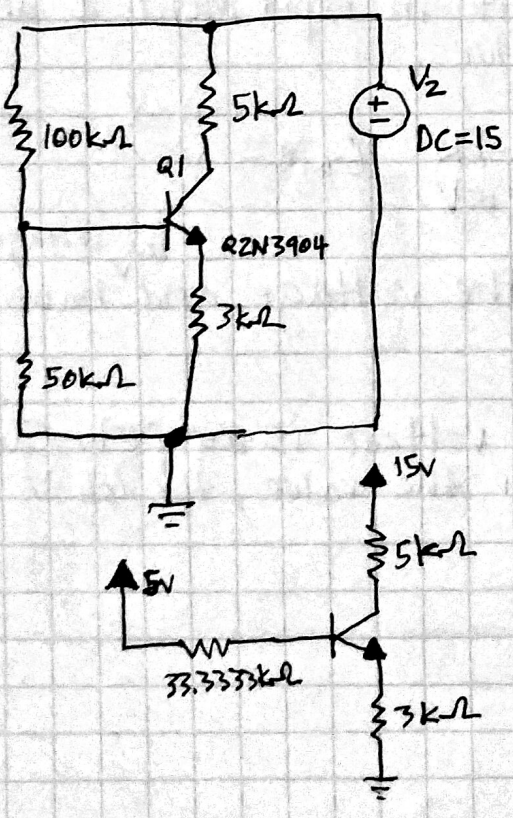
d)
This is useful for finding the type of transistor you will be using.

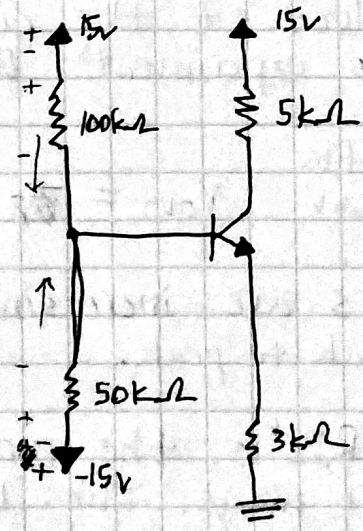
2N3906

RED +	BLK −	Meter shows conduction?
1	2	~~2V~~ ~~open~~ .7V
1	3	~~2V~~ ~~open~~ open
2	3	~~open~~ open
2	1	open
3	1	open
3	2	.7V

Experiment 2: DC operation of BJT

1.





$$V_{Th} = \frac{15(100k\Omega) - 15v(50k\Omega)}{100k\Omega + 50k\Omega} = 5v$$

$$R_{Th} = \frac{100k\Omega \cdot 50k\Omega}{100k\Omega + 50k\Omega} = 33.333k\Omega$$

$$5 - I_B(33.333k\Omega) - I_E(3k\Omega) - 0.7 = 0$$

$$I_E\left(\frac{33.333k\Omega}{151} - 3k\Omega\right) = -4.3v$$

$$I_E = 1.3mA$$

$$I_B = \frac{1.3}{151} = 8.8\mu A$$

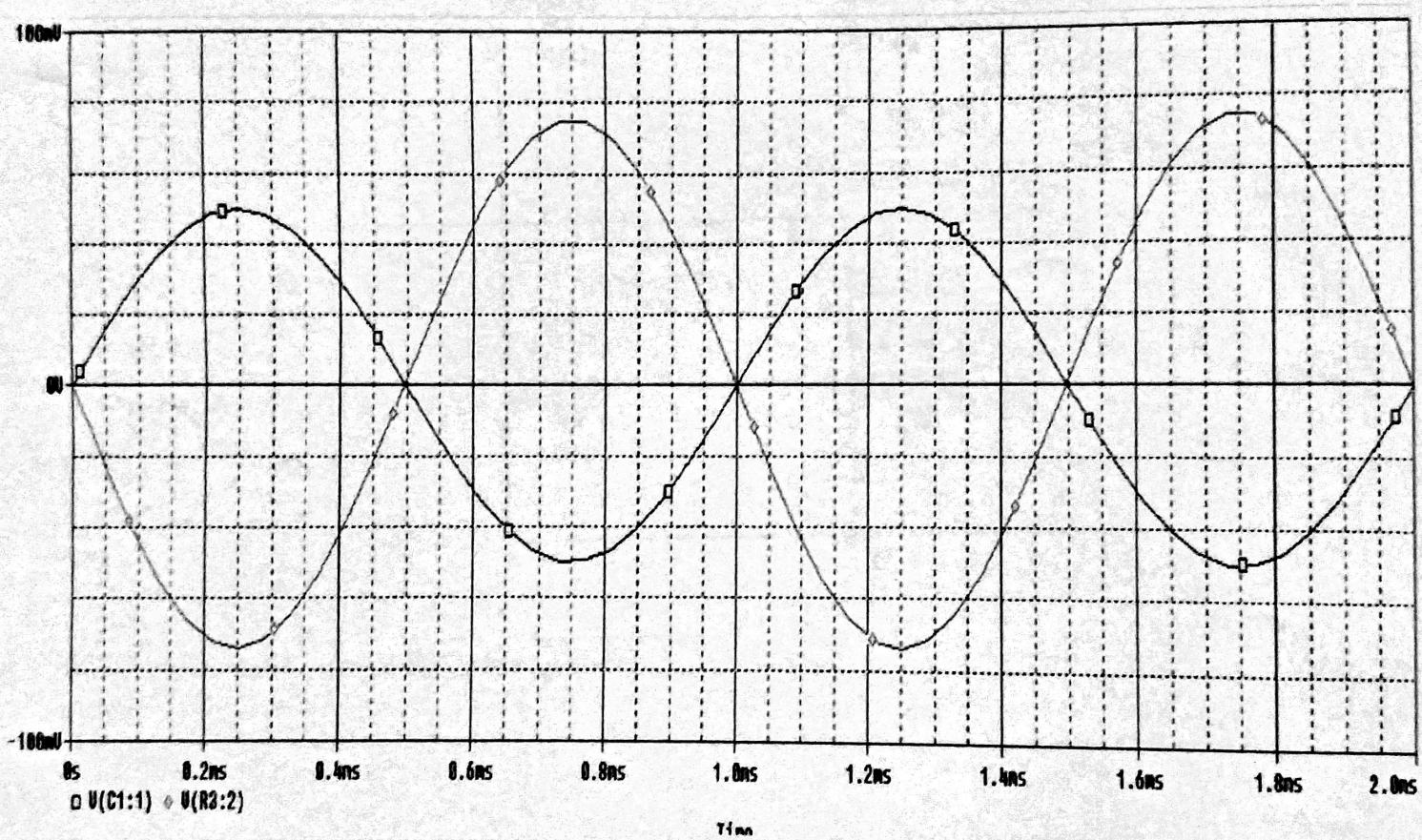
$$I_C = 8.8\mu A \cdot 150 = 1.3mA$$

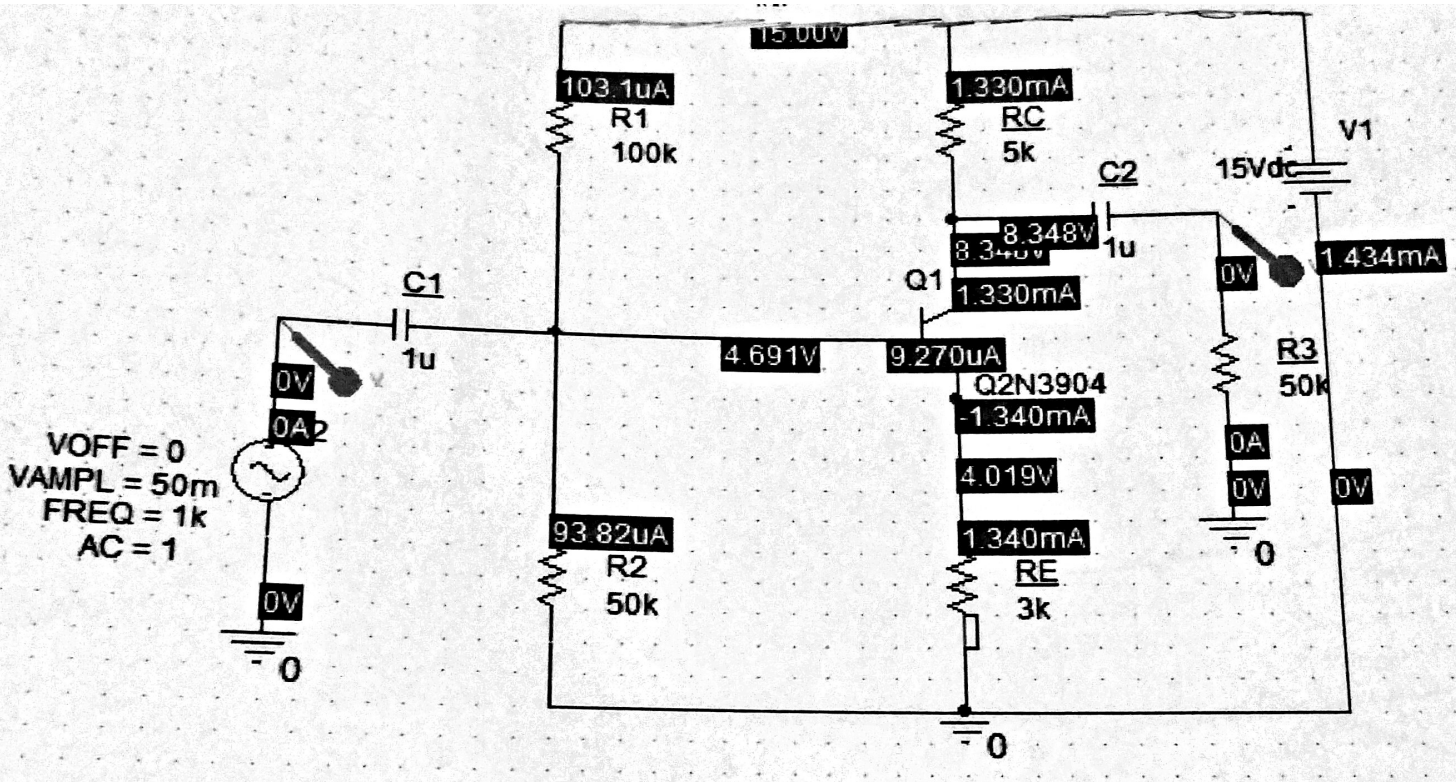
$$V_B = 5 - 8.8\mu A(33.333k\Omega) = 4.7v$$

$$V_E = 4.7 - 0.7 = 4v$$

$$V_C = 15 - 1.3mA(5k\Omega) = 8.5v$$

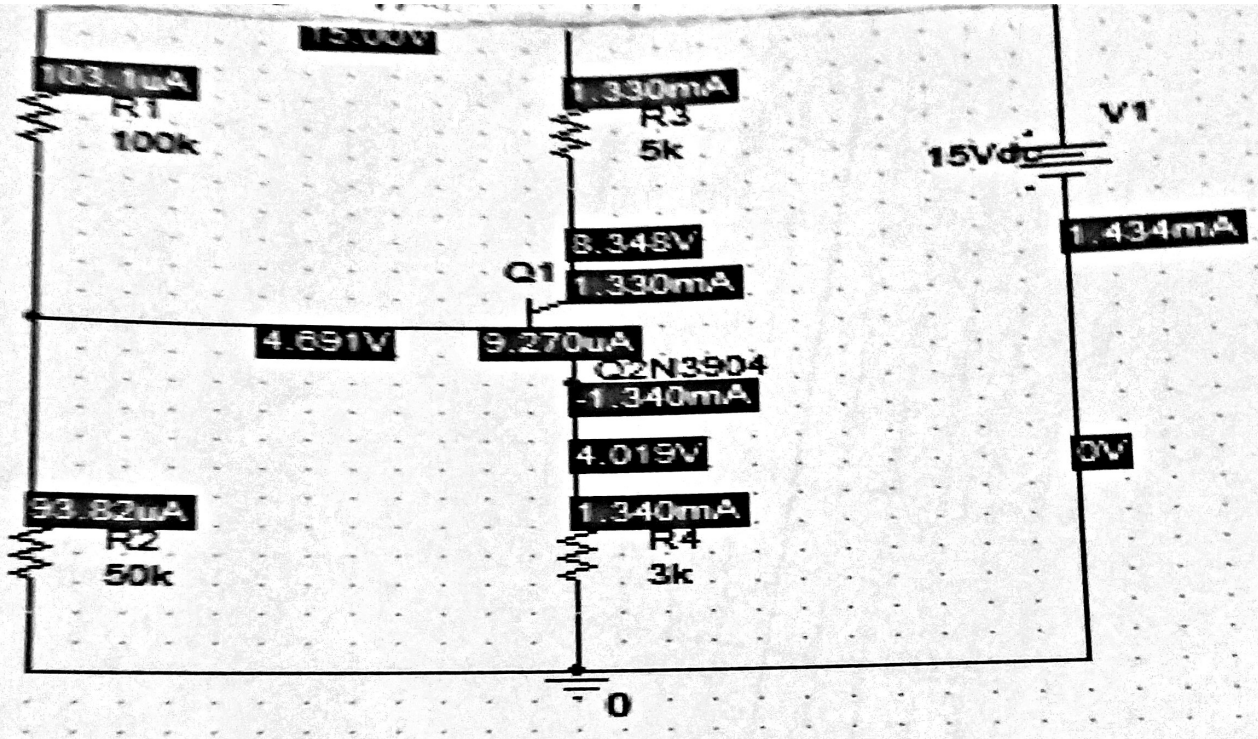
1.


100mV
0V
-100mV
0s
0.2ms
0.4ms
0.6ms
0.8ms
1.0ms
1.2ms
1.4ms
1.6ms
1.8ms
2.0ms
V(C1:1)
V(R3:2)
Time



Values are same for DC attributes.

2.



I_E is about the same as hand analysis.

I_B is a little higher on here compared to hand analysis.

I_C is about the same as hand analysis.

V_B is about the same as hand analysis.

V_E is about the same as hand analysis.

V_C is a little lower compared to hand analysis.

3/3/16

3. $V_B = 4.6V$
$V_C = 6.6V$
$V_e = 4V$

$5 - I_B(33.333k\Omega) = 4.6V$

$I_B = 12\,\mu A$

$I_B = \frac{I_E}{151}$

$I_E = I_B(151)$

$I_E = 1.8mA$

$15 - I_C(5k) = 6.6V$

$I_C = 1.7mA$

I_E is higher in the physical measurements.
I_B is also higher in the physical measurements.
I_C is a little bit higher in the physical measurements.

Experiment 3: Simulations

1. The DC values of the circuit in experiment 1 are the same as this experiment's DC values.

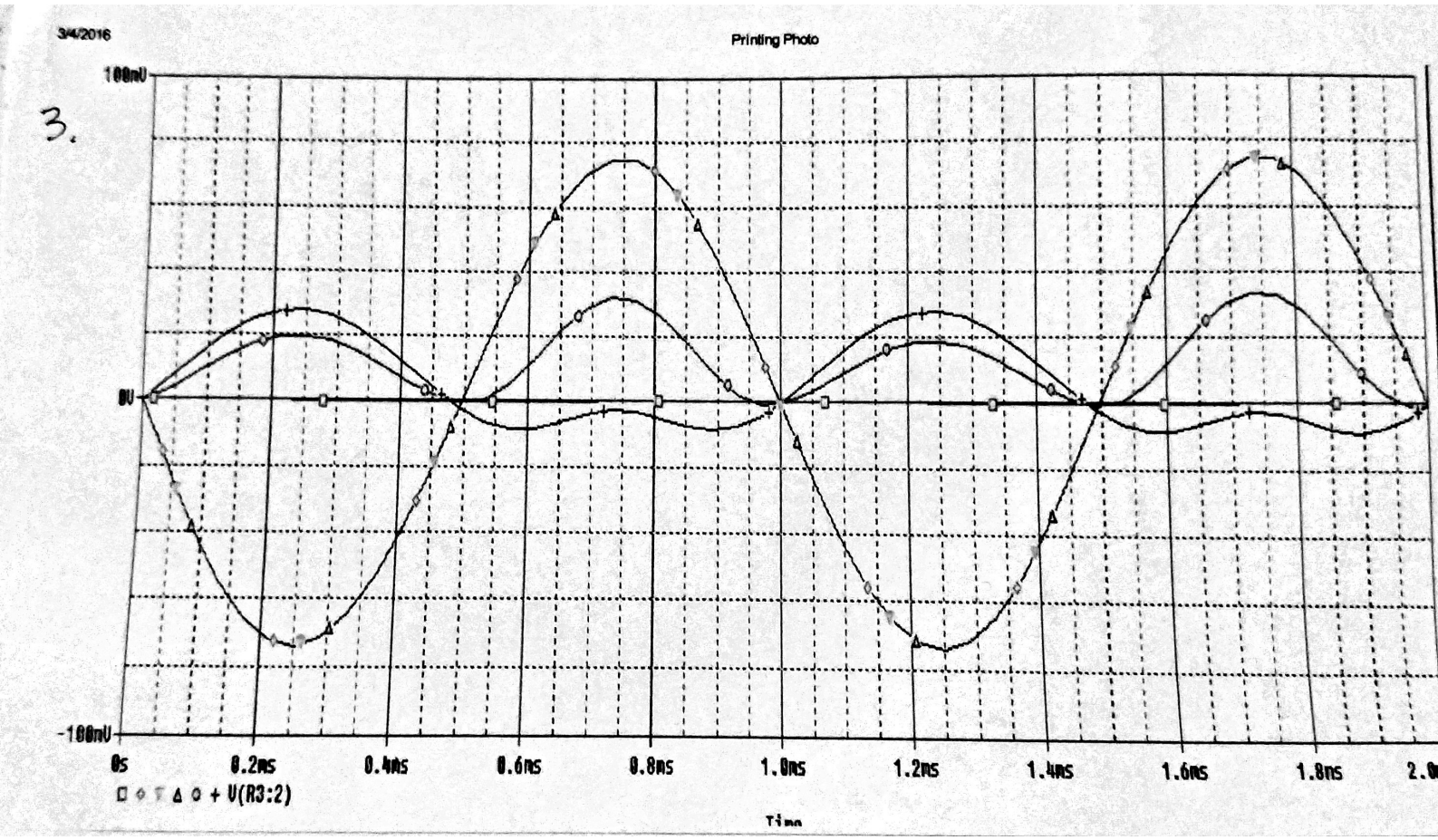
$V_{in} = 100mV_{pk\text{-}pk}$ $V_{out} = 74mV_{pk\text{-}pk}$ $Gain = \frac{74mV}{100mV} = .74$

2. The capacitors are increasing the voltage and the voltages have a smaller peak to peak.

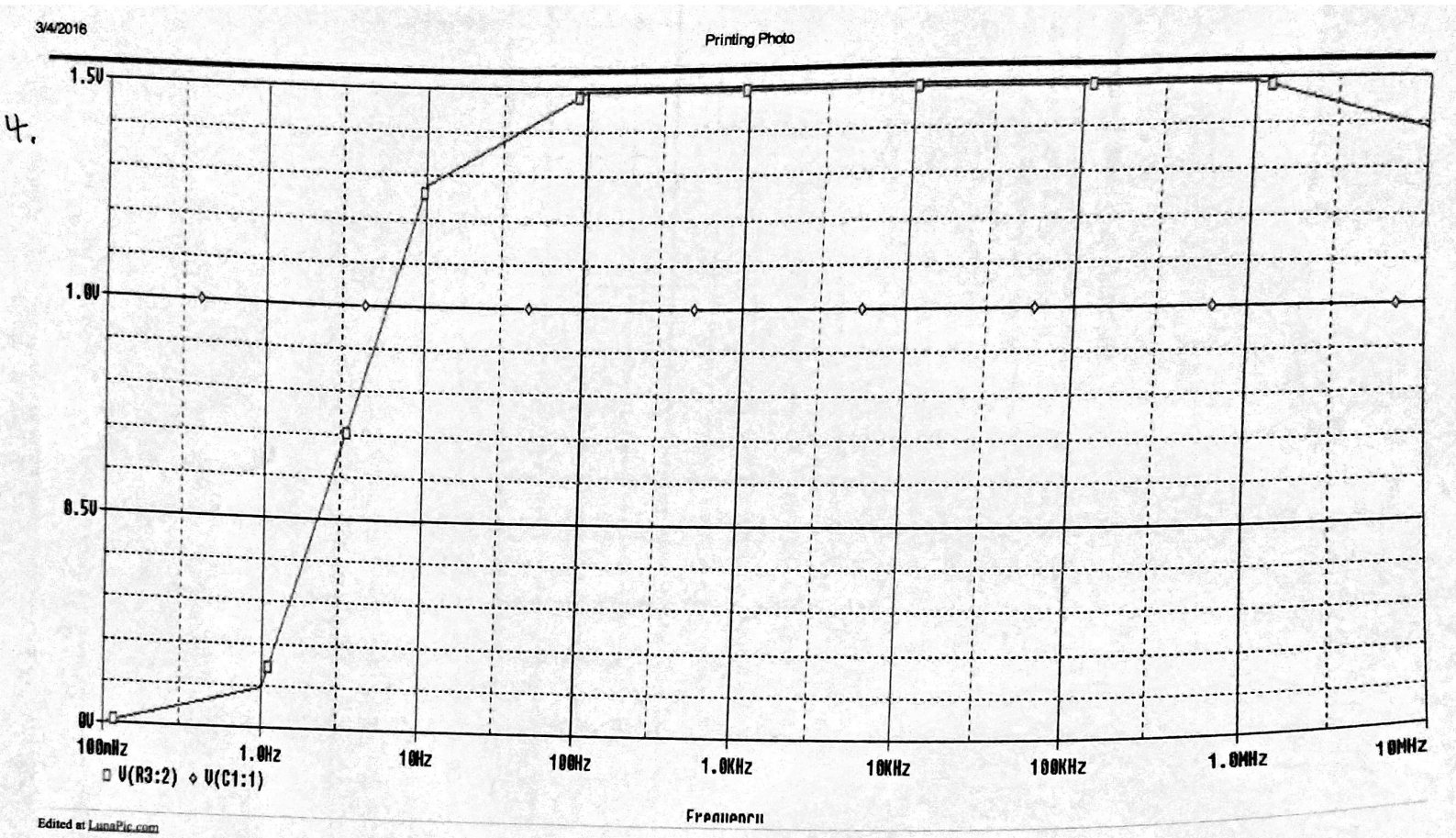
3. The higher R2 is, the more voltage is output. Same for the other way. The lower the value, the lower the voltage.

4.

3.


3/4/2016
Printing Photo
100mV
0V
-100mV
0s
0.2ms
0.4ms
0.6ms
0.8ms
1.0ms
1.2ms
1.4ms
1.6ms
1.8ms
V(R3:2)
Time

4.

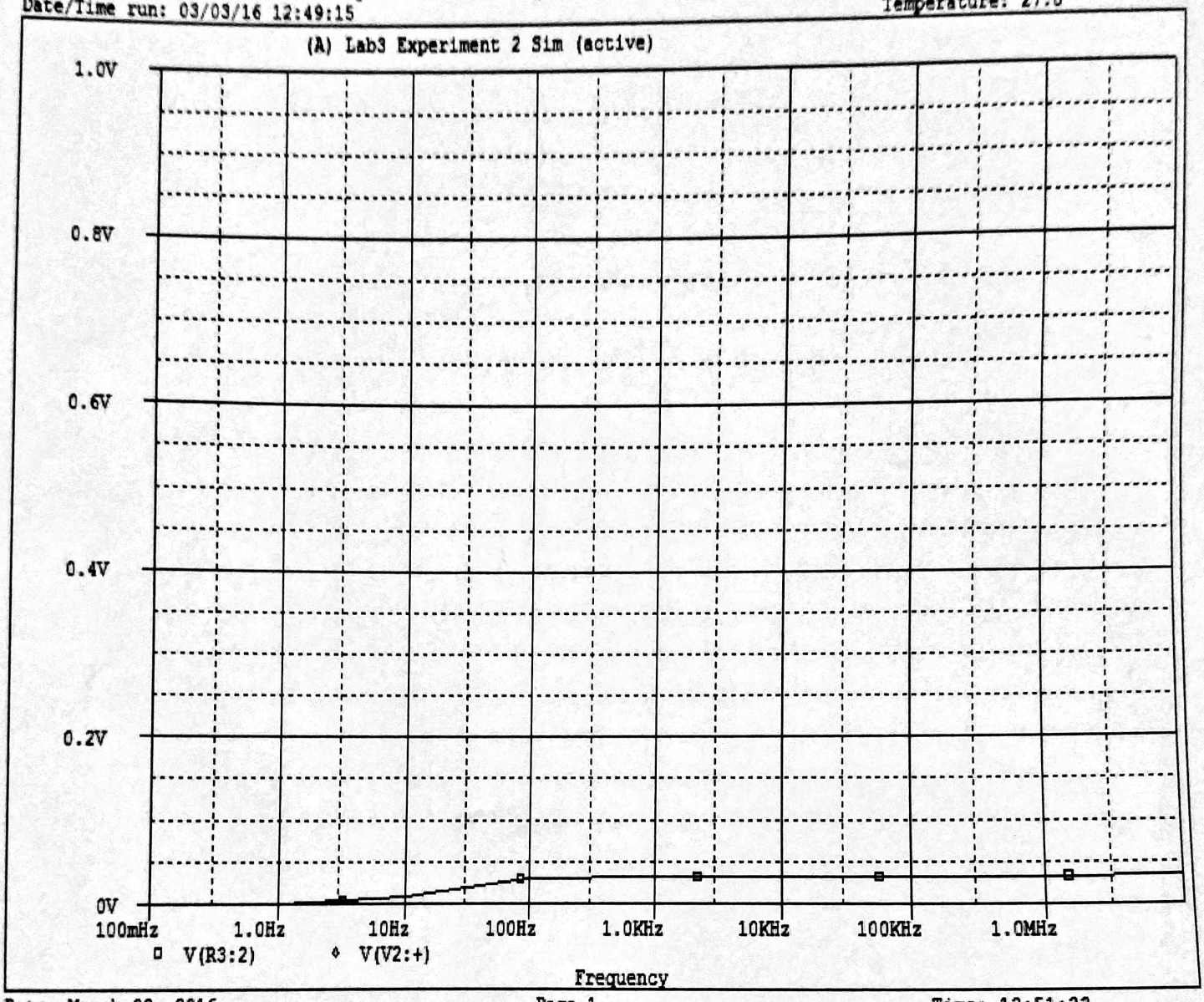


$$\text{gain} = \frac{V_{out}}{V_{in}} = \frac{1.5}{1} = 1.5$$

** Profile: "SCHEMATIC1-Lab3 Experiment 2 Sim" [C:\OrCAD\OrC...

Date/Time run: 03/03/16 12:49:15

Temperature: 27.0



Date: March 03, 2016 Page 1 Time: 12:51:33

	Gain	Rin	Rout
Sim	1.5*	92.8Ω	1.0433MΩ
Meas	1.5	106kΩ	69.45MΩ

* Everybody's seems to be way off.

5.

Why is it attenuating?

Basic Ohm's law: The resistance is lower, therefore the voltage drop is smaller. $V = I \cdot R$.

6.

$$I_{in} = \frac{V_{test} - V_{in}}{R_{test}} \qquad R_{in} = \frac{V_{in}}{I_{in}}$$

$V_{in} = 4.64V$

$V_{test} - V_{in} = 320mV$

$$R_{in} = \frac{4.64V}{50mA} = 92.8\Omega$$

7.

$$R_O = \frac{V_{Th} - V_L}{V_L} \cdot 50k \qquad V_{Th} = 0 \quad V_L = 75mV$$

?

$$\frac{1.64V - 75mV}{75mV} \cdot 50k = 1.0433M\Omega$$

Pk-to-Pk voltage at Rout is 150mV

Experiment 3: Measurements of BJT Circuits

1.

Peak-to-Peak of Vin = 103mV
Peak-to-Peak of Vout = 155mV

Gain = 1.5

2.

$(1.5)(0.708) = 1.062$

Gain = 1.062

$$\frac{103}{Vout} = 1.062$$

Peak-to-Peak of Vout = 96.98mV

3.

23.3 Hz is the starting frequency for the bandwidth of the circuit with a Vin of 103mV (Peak-to-Peak) and Vout of 96.98mV. (Peak-to-Peak)

4.

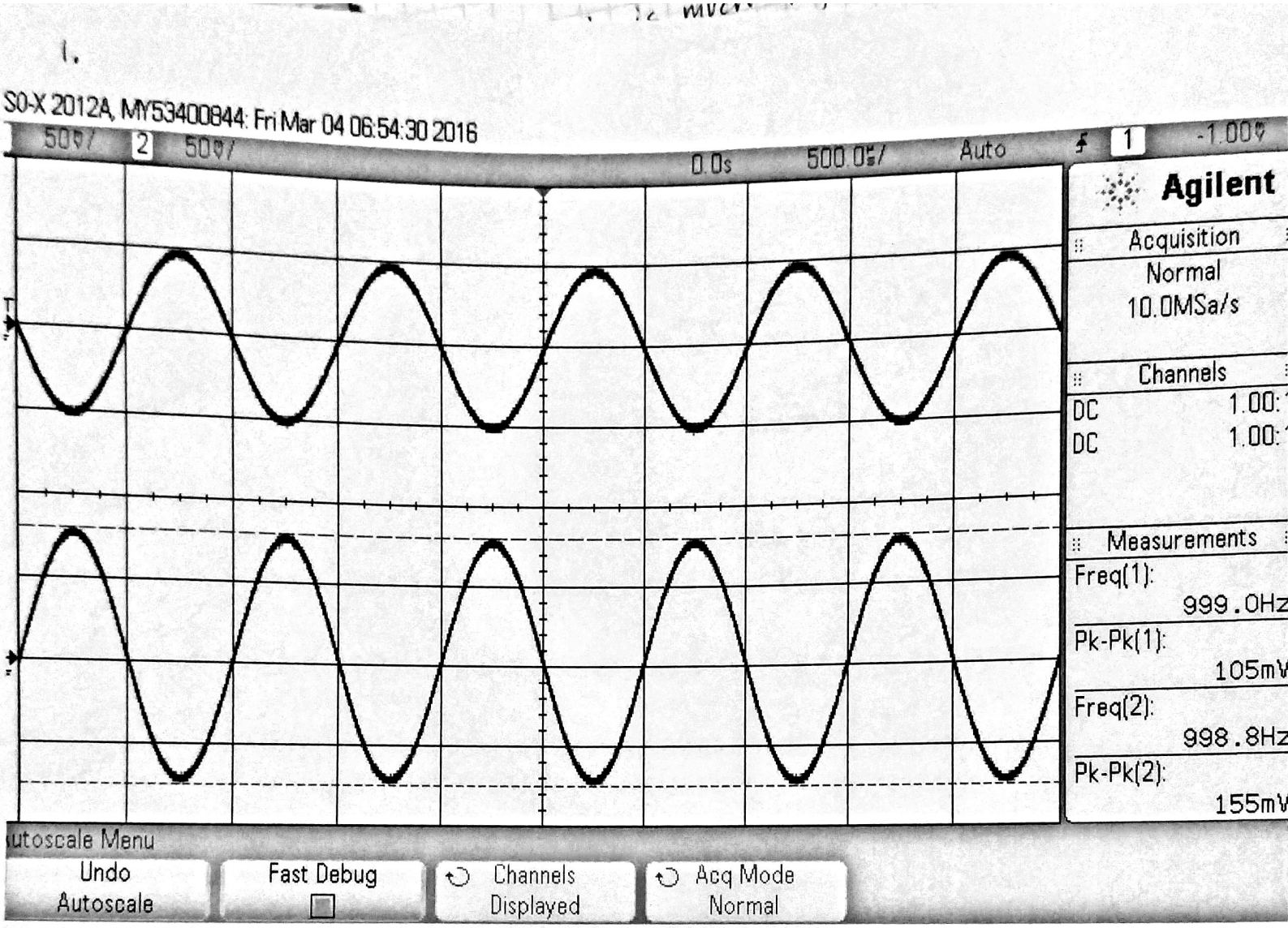
$$I_{in} = \frac{V_{test} - V_{in}}{2k} = \frac{5.4mV - 5.3mV}{2k} = \frac{.1m}{2k} = 50nA \qquad R_{in} = \frac{5.3mV}{50nA}$$

Rin is off by a factor of 1k, so very far off. Rin = 106k

$$R_o = \frac{8.34V - 6mV}{6mV} \cdot 50k = 69.45M\Omega$$

About 68M million more than in the simulation. A little better.

1.


S0-X 2012A, MY53400844: Fri Mar 04 06:54:30 2016
50Ω/
2
50Ω/
0.0s
500.0s/
Auto
1
-1.00
Agilent
Acquisition
Normal
10.0MSa/s
Channels
DC
DC
Measurements
Freq(1):
999.0Hz
Pk-Pk(1):
105mV
Freq(2):
998.8Hz
Pk-Pk(2):
155mV
Autoscale Menu
Undo Autoscale
Fast Debug
Channels Displayed
Acq Mode Normal

5

$V_{out} = 840mV$

$V_{in} = 60mV$

$Gain = \frac{840mV}{60mV} = 14$

The gain is much higher due to the capacitor in the Emitter.

6. $Gain = \frac{V_{out}}{V_{in}} = \frac{107mV}{107mV} = 1$

R_{in}: $I_{in} = \frac{V_{test} - V_{in}}{R_{test}} = \frac{35.1mV - 26.1}{10k} = .9\mu A$

$R_{in} = \frac{26.1mV}{.9\mu A} = 29k\Omega$

R_{out}:

$$R_{out} = \frac{V_{Th} - V_L}{V_L} \cdot R_L = \frac{35.2mV - 35.18mV}{35.18mV} \cdot 50k = 28\Omega$$

The Rin value seems to be close to the given simulation and so does the Rout.

* It seems a lot of the resistance measurements are off by alot for many people in the earlier measurements. I asked a few TA's and they are not sure why.

Also, grading rubric didn't make sense.