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EELE 317
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Lab 8 Report

Introduction:

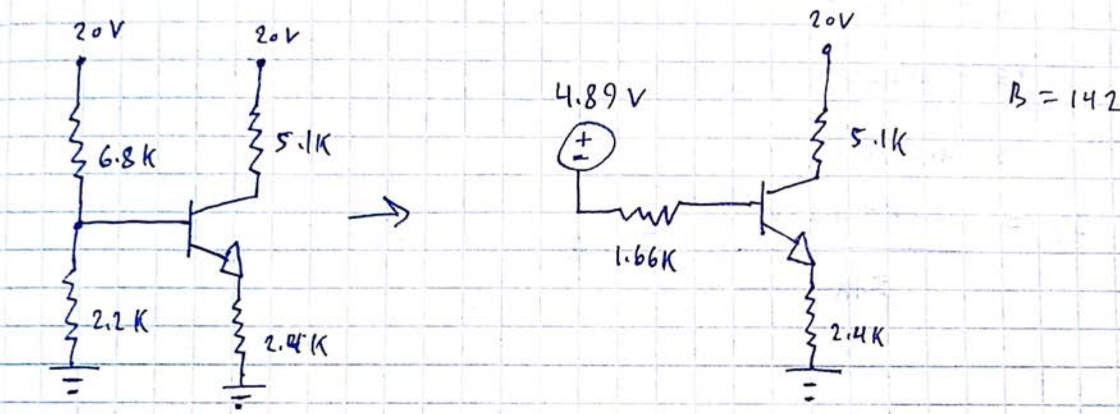
In this lab I built a single transistor BJT common emitter amplifier. After constructing the system I used different measurement techniques to calculate the gain, input and output impedances, and frequency response.

Pre-lab:

1. Data from Lab 6
   - Bac = 144
   - Bdc = 142
   - Va = 270 V

2) Hand Calculations

2)



KVL: $4.89V - 2.4K(143)I_B - 0.7 - 1.66K\,I_B = 0$

$4.19V = 344\,860\,I_B$

$I_B = 1.215 \times 10^{-5}$ A $\qquad V_B = 4.87$ V

$I_B = 0.012$ mA $\qquad V_C = 11.2$ V

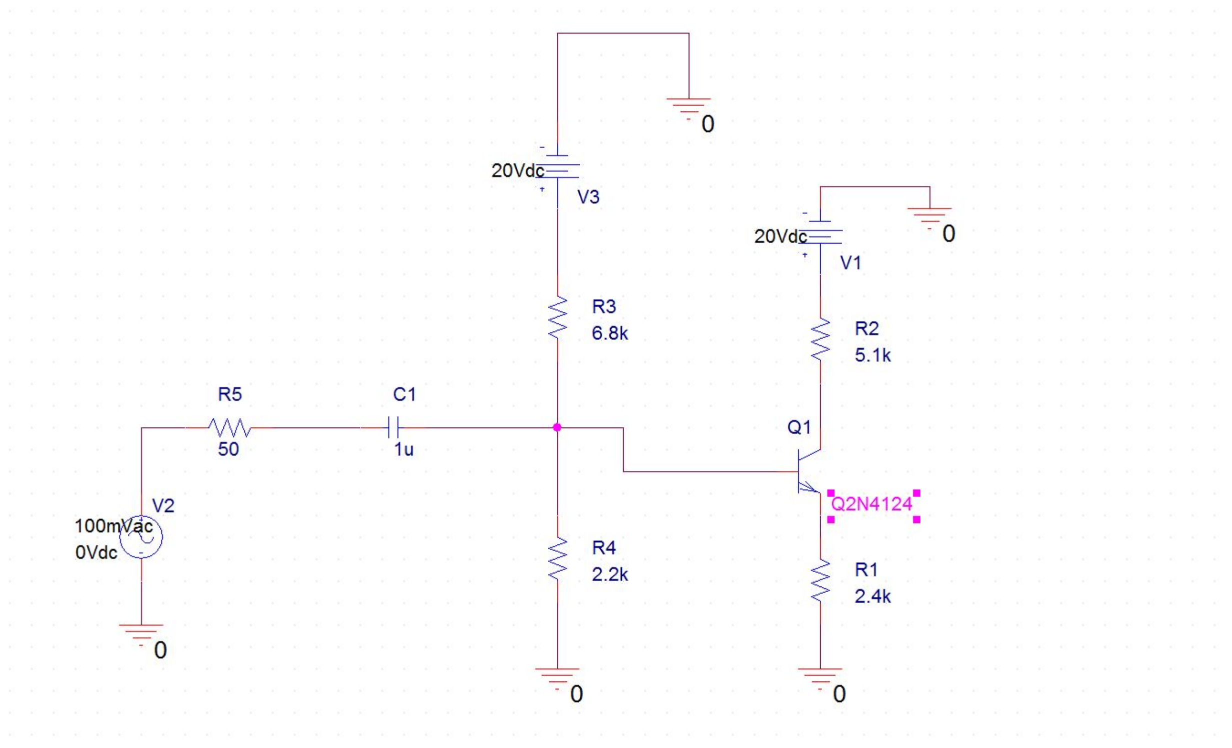
$I_C = 1.725$ mA $\qquad V_E = 4.1688$ V

$I_E = 1.737$ mA

DC Bias Conditions:

Vb = 4.87 V	Ib = 0.012 mA
Vc = 11.2 V	Ic = 1.725 mA
Ve = 4.17 V	Ie = 1.737 mA

3) SPICE Simulations



Experiments:

Experiment 1:

1) Vc = 11.28V, Ve = 4.22 V, Vb = 4.89 V

   Ic = $\frac{20V-11.28V}{5.1k\ ohms}$ = 1.71 mA

2. Using 200 mVpp input waveform

a)

Signal	DC value	AC variation pp	Phase
V1	4.89 V	216 mV	0 radians
Vb	4.89 V	480 mV	0 radians
Vc	11.2 V	1.1V	pi radians
Ve	4.2V	320 mV	0 raians

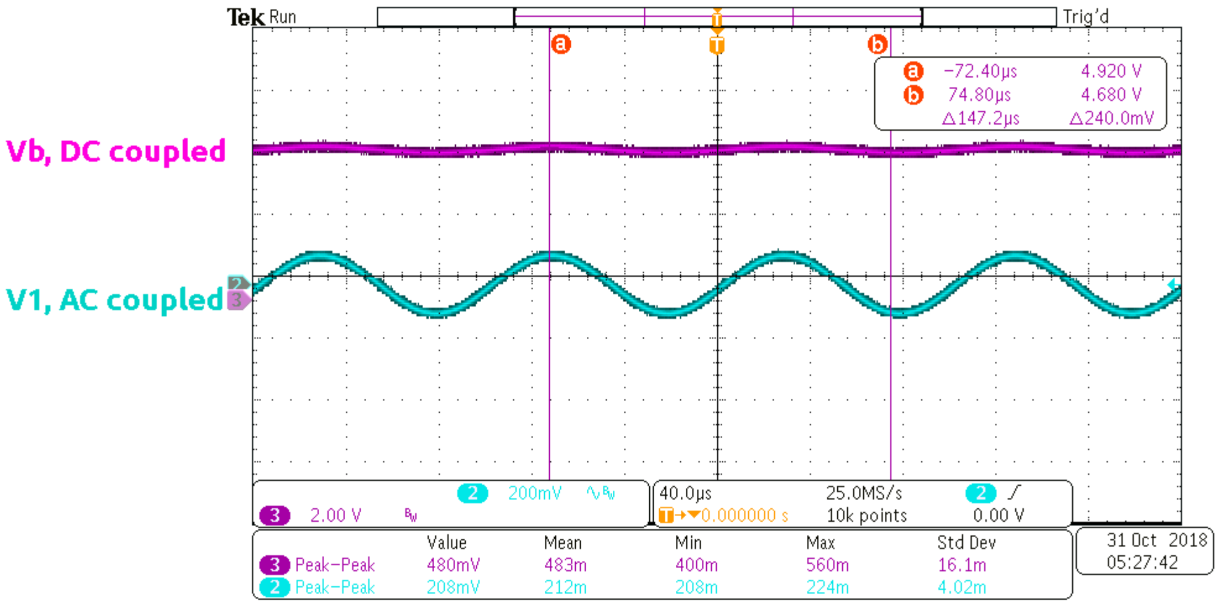
V1, Vb, and Ve are all in phase. Vc is offset by a phase shift of pi radians, this signal observes a peak when the other signals are at a minimum.

DC Conditions Comparison:

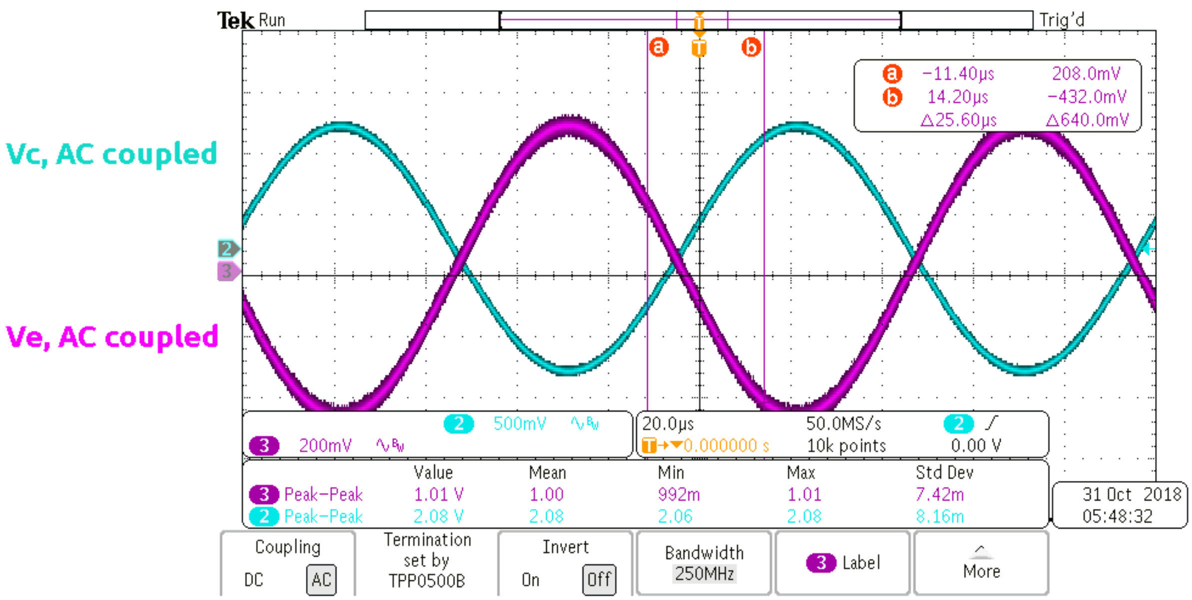
Quantity	Calculations	Measurements
Ic	1.725 mA	1.71 mA
V1	DNE	4.89 V
Vb	4.87 V	4.89 V
Vc	11.20 V	11.20 V
Ve	4.17 V	4.20 V

There is no significant variation between the DC pre-lab calculations and multimeter/scope measurements.

DC and AC Measurements



Phase Measurements



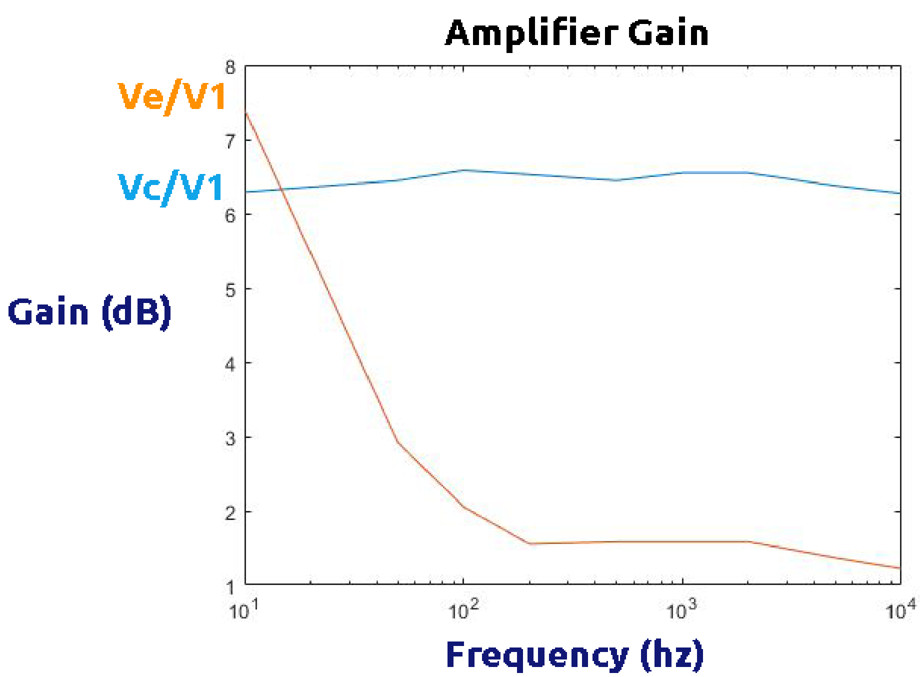
b)

F (hz)	V1 (mv AC)	Vb (mv AC)	Vc (mv AC)	Ve (mv AC)
10	32	64	66	75
50	100	130	210	140
100	150	180	320	190

200	184	220	390	220
500	200	230	420	240
1k	200	235	425	240
2k	200	235	425	240
5k	205	235	427	240
10k	205	235	422	236

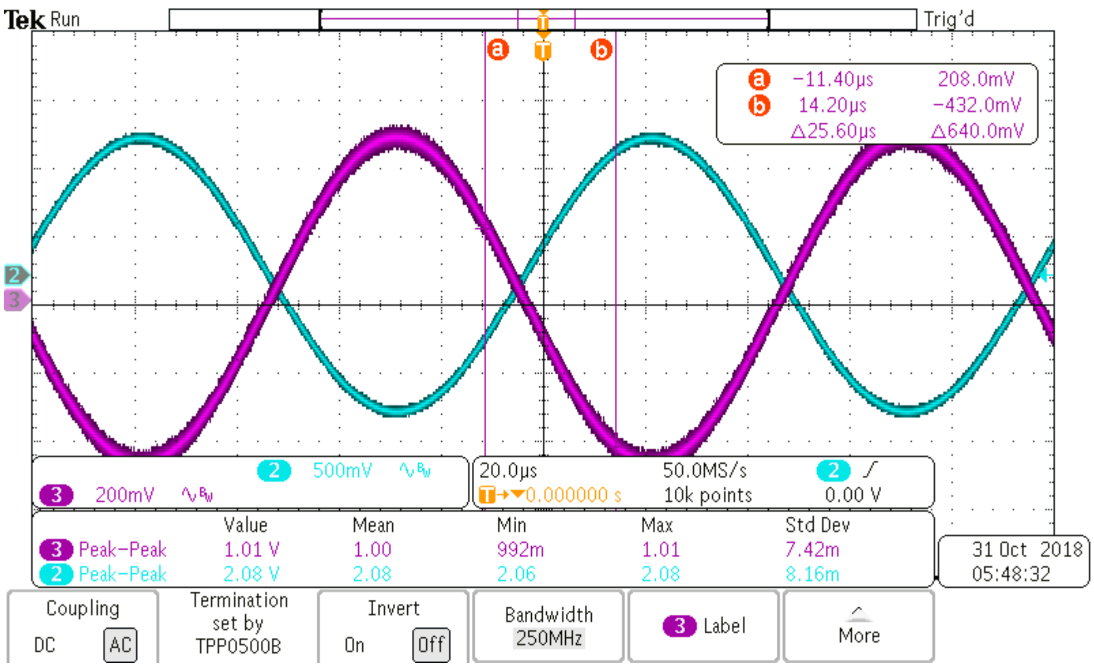
Gain:

F(hz)	Vc/V1	Ve/V1
10	2.06	2.34
50	2.10	1.40
100	2.13	1.27
200	2.12	1.20
500	2.10	1.20
1k	2.13	1.20
2k	2.13	1.20
5k	2.08	1.17
10k	2.06	1.15

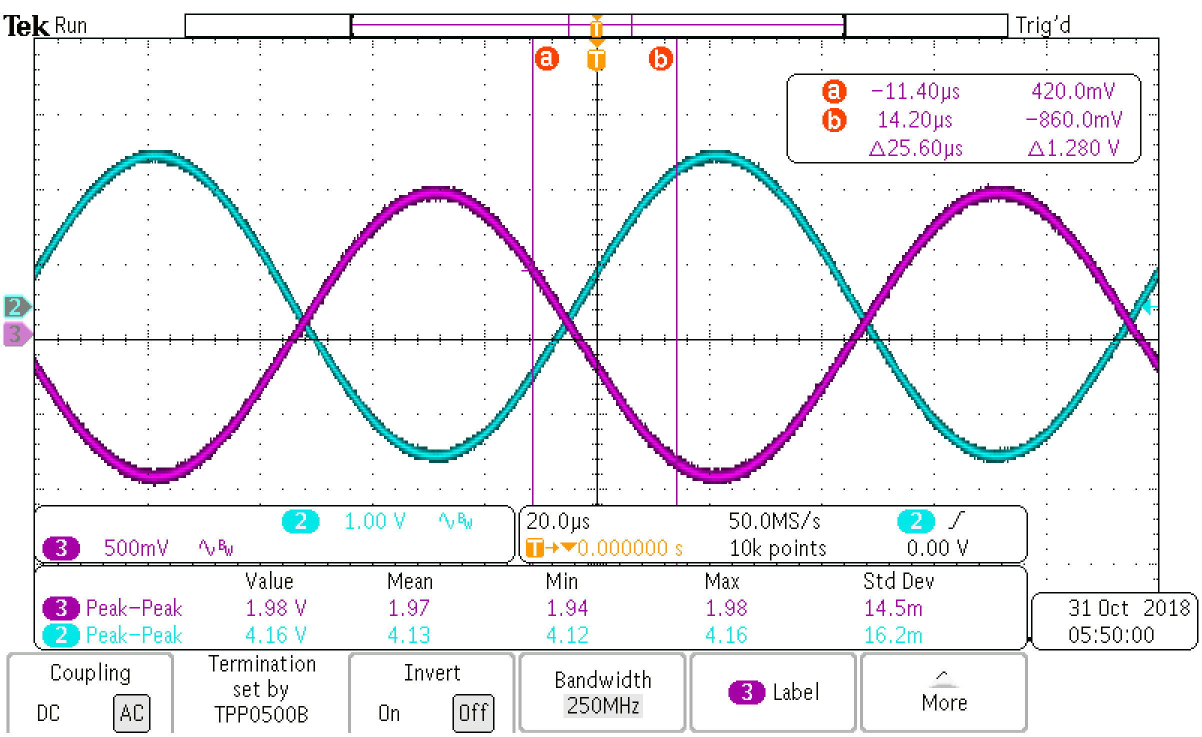


c) When viewing the output waveforms at V1 = 1, 2, and 4 Vpp I observed the expected growth with no distortion. When reaching V1 =10 Vpp I began to notice some clipping in the output waveform. This is likely due to the transistor leaving the active region once the swing in voltage at the collector becomes great enough.

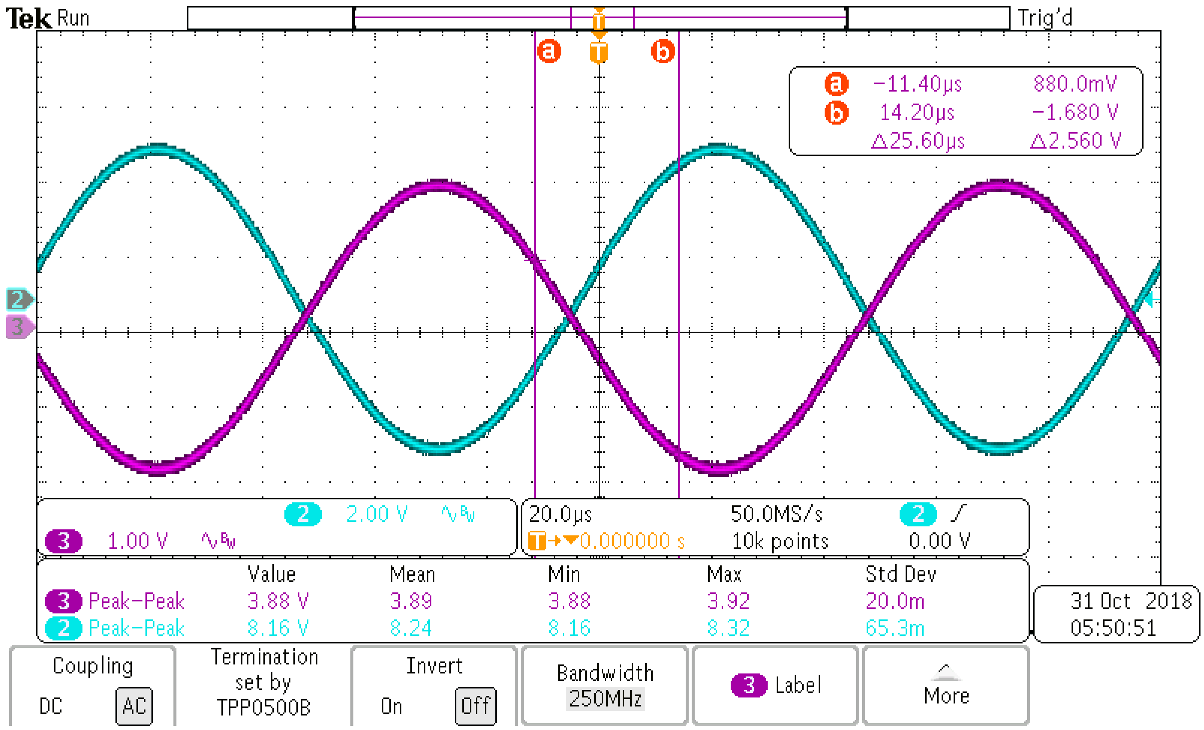
V1 = 1V



V1 = 2V



V1 = 4V



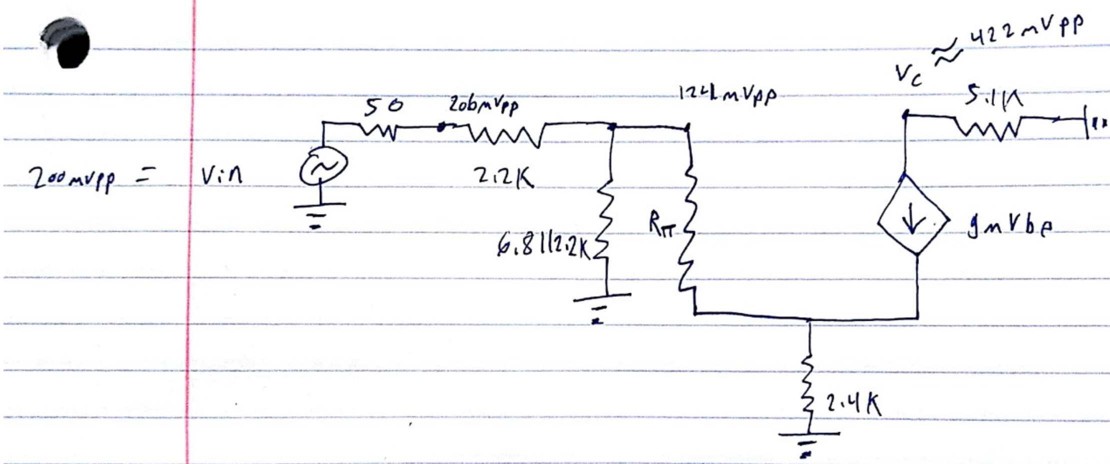
Experiment 2)

Part 1)

At 10khz, Vin = 200 mVpp

Vx = 206 mVpp

Vy = 124 mVpp



$$\frac{206-124}{2.2K} = \frac{124-422}{R_{VB}}$$

$$R_{VB} = \left| \left(\left(\frac{206-124}{2.2K} \right) \bigg/ \left(124-422 \right) \right)^{-1} \right|$$

$$R_{VB} = 7995.12\ \Omega$$

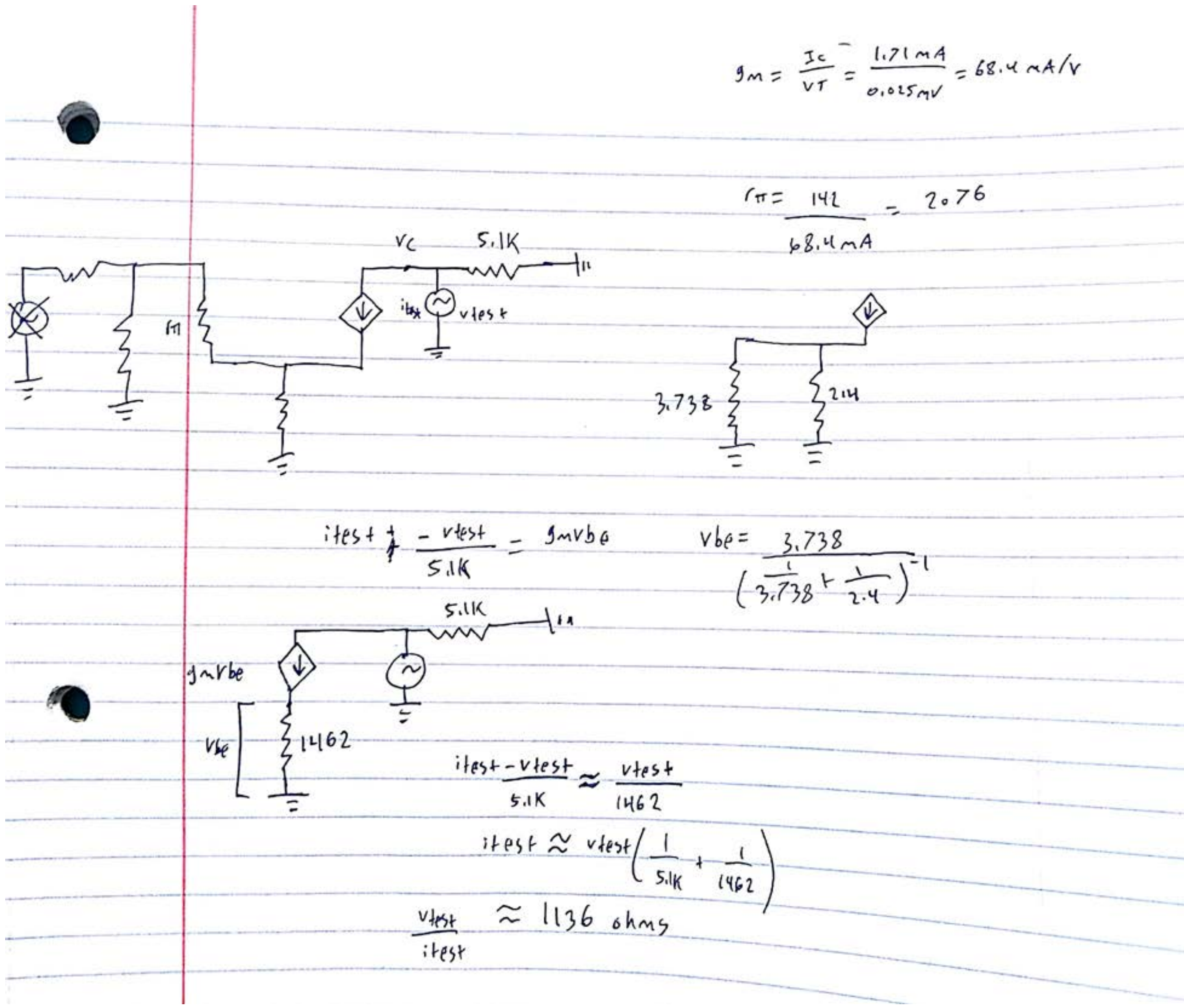
Input resistance at Vb = 7995.12 Ω

An estimate of the input resistance is produced by comparing the change in AC voltage swing across the 2200 Ω resistor to the change in AC voltage swing between the base and collector across a simplified input resistor RVb.

Part 2)

At 10khz without load, Vc AC = 422 mVpp

At 10khz with load, Vc AC = 310 mVpp



Output impedance = 1136 Ωs

Experiment 3)

Vin	V1	Vc	Gain
200 mVpp	204 mV	5V	24.51
300 mVpp	288 mV	6.78 V	23.54

By adding the capacitor in parallel with the resistor emitter, the DC bias is unaffected and the emitter resistor is entirely bypassed in the small signal analysis. Because the capacitor acts as a short at high frequencies the emitter terminal is tied to ground at AC. This leads to a larger Vbe and thus a greater current through the transistor. This increases the amplifier gain by a factor greater than 10.

Gm = $\frac{Ic}{Vt} = \frac{1.71\ mA}{25\ mV}$ = 68.4 mA/V

Rπ = $\frac{B}{Gm} = \frac{142}{68.4\ mA/V}$ = 2076.02 Ω