EECS 2210: Lab 4: AC Analysis, BJT circuits Session

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OBJECTIVES

In this lab, the students will learn AC analysis of a single stage BJT transistor circuit.

PRELAB

In the following circuit assume beta=100 and Vbe=0.7:

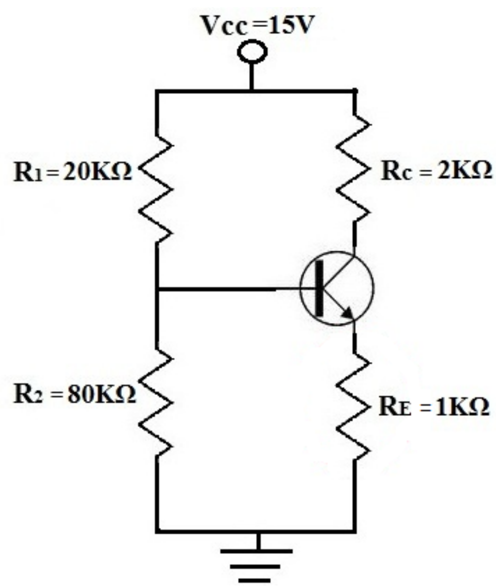

Figure 1

From Lab 3

1. Calculate Ic and Vce and determine if the transistor is in linear (normal) mode.

   The transistor in saturation mode Vce=0.016V Ic=0.23mA

2. Change resistor(s) so that Ic=3mA and Vce=6volts.

   R1=3R2
   R2=10kohm
   R1=30kohm
   Re=1kohm
   Rc=2kohm

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In this lab

1. Let us assume, we have a common emitter amplifier with input/output coupling capacitors C_B and C_C. The signal generator should be connected to input and a resistor (R>20KΩ, as a load) is connected to the output. Draw the complete circuit, select the capacitors. Hint: The capacitors C_B and C_C should be in the range of 1-50uF.
   9

2. Assume the input signal's amplitude is smaller than V_T, and
   a. Calculate A_V
   b. Calculate Z_{in}
   c. Calculate Z_{in}
3. Assume R=2KΩ and repeat (2)

EXPERIMENT

Requirement:

In this lab, the following elements and instruments will be used.

1. Elements
   a. 2N3904FS
   b. Resistors
   c. Capacitors
2. Instruments:
   a. Power supply
   b. Oscilloscope and/or Voltmeter

Instruction:

- From Lab 3

1. Test the transistor and assure the transistor works properly or not.
2. Assemble the circuit shown in Figure 1 on breadboard. You should use the elements in the list of resistors and potentiometers (see next page).
3. Measure Ic and Vce and determine if the transistor is in its normal operational mode.
4. Change the resistor (s) similar to question 2 in the prelab section so that Ic=3mA and Vce=6 volts. You should use the elements in the list of resistors and potentiometers (see next page).

In this Lab

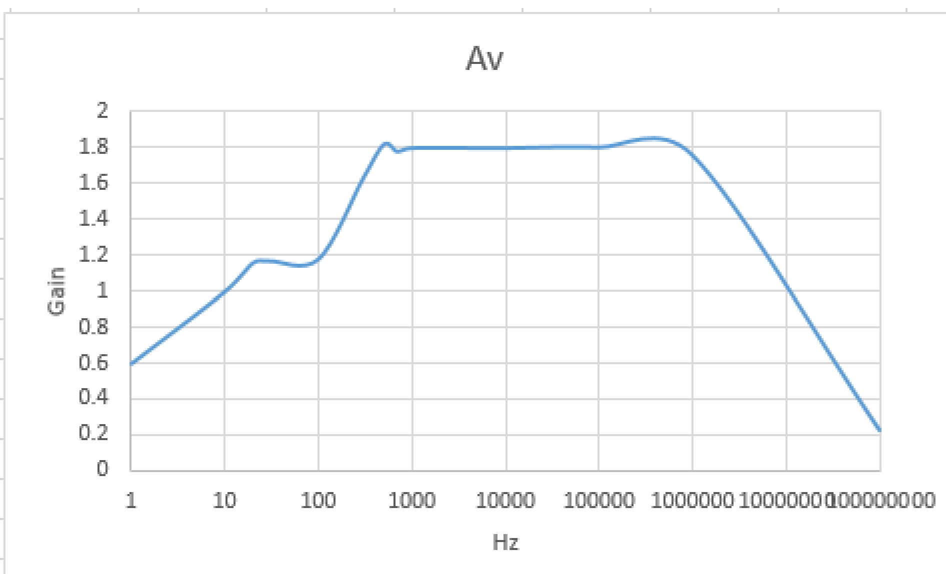
1. Adjust the input signal generator to $V_{in}=A_I\sin(2\pi ft)$, A_I=2mV and f=1KHz.

We used 150mV.
f=1kHz

2. Connect V_{in} to the input and a resistor (R=1.5KΩ) to the output.
We used 30kOHM

3. Observe A_I (while V_{in} is connected) and output signal's amplitude A_O ($V_{out}=A_O Sin(2\pi ft)$ and obtain A_v.
   a. Without changing A_I=2mV, select f= 1Hz, 10Hz, 100Hz, 1000Hz, 10KHz, 100Hz, 1MHz and 10MHz and Obtain A_V values for all different frequencies and draw A_V frequency response curve (A_V versus f).

Hz	Av
1	0.6
10	1
20	1.16
30	1.17
100	1.18
300	1.63
500	1.82
700	1.78
1000	1.8
10000	1.8
100000	1.804
1000000	1.76
100000000	0.23



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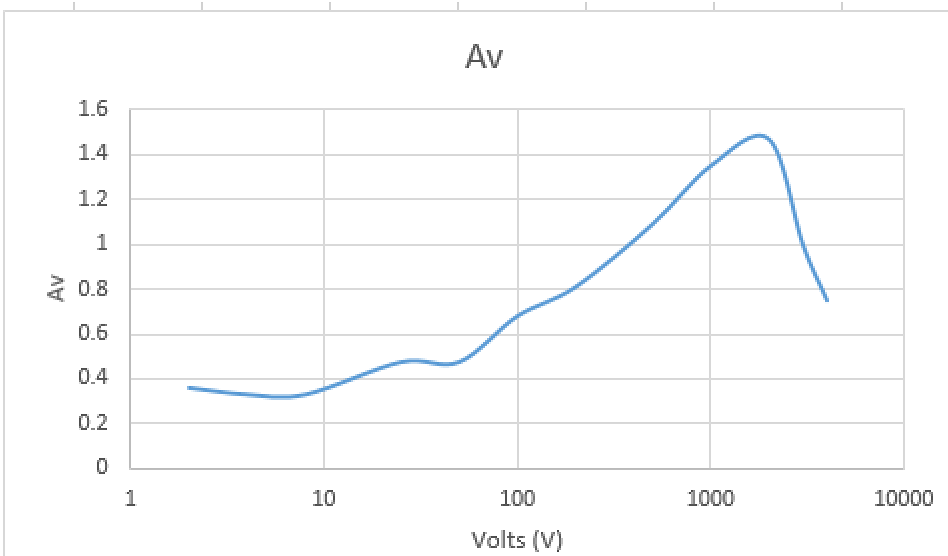
b. Without changing frequency =1KHz, select A_I= 0.1 mv, 1mV, 2mV, 4mV, 8mV, 25mV, 50mV, 100mV, 200mV, 500mV, 1V, 5V and obtain A_V values for all different A_I and draw A_V amplitude response curve (A_V versus A_I).

Mv	Av
2	0.36
4	0.33
8	0.33
25	0.475
50	0.475
100	0.68
200	0.81
500	1.09
1000	1.35
2000	1.47
3000	1
4000	0.75
5000	0.65



Advanced part of this lab ***(optional for bounce)***

1. Select a capacitor and bypass Resistor RE.
   a. Similar to 3a in the last part, assume A_I=2mV and select a range of frequencies f and obtain A_V frequency response (Av versus f).

EECS 2210: Lab 4: AC Analysis, BJT circuits **Names: Sean O'Brien 213735741**

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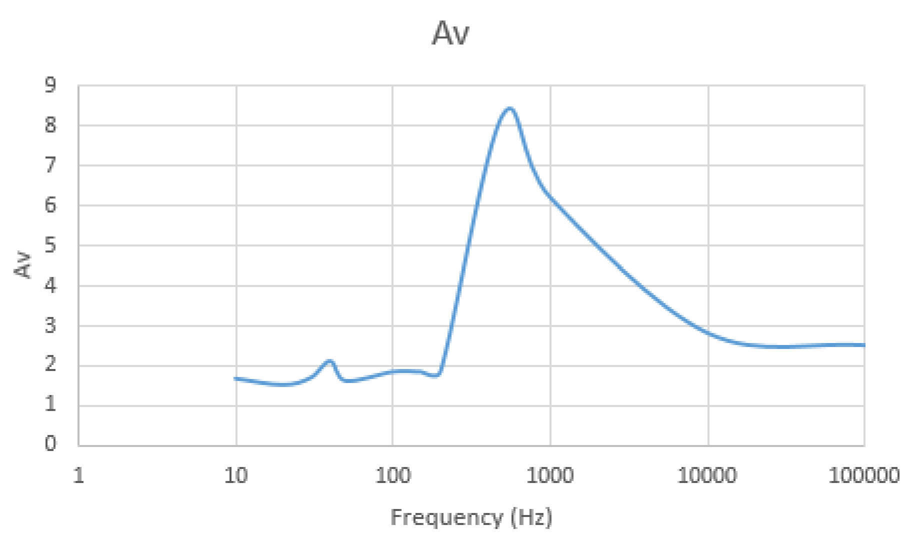
Hz	Av
10	1.66
20	1.5
30	1.68
40	2.1
50	1.6
100	1.83
150	1.83
200	1.83
500	8.3
1000	6.2
10000	2.8
100000	2.5



b. Similar to 3b in the last part, assume f=1KHz and select various A_I and draw the curve of Av versus input signal amplitudes.

EECS 2210: Lab 4: AC Analysis, BJT circuits **Names: Sean O'Brien 213735741**

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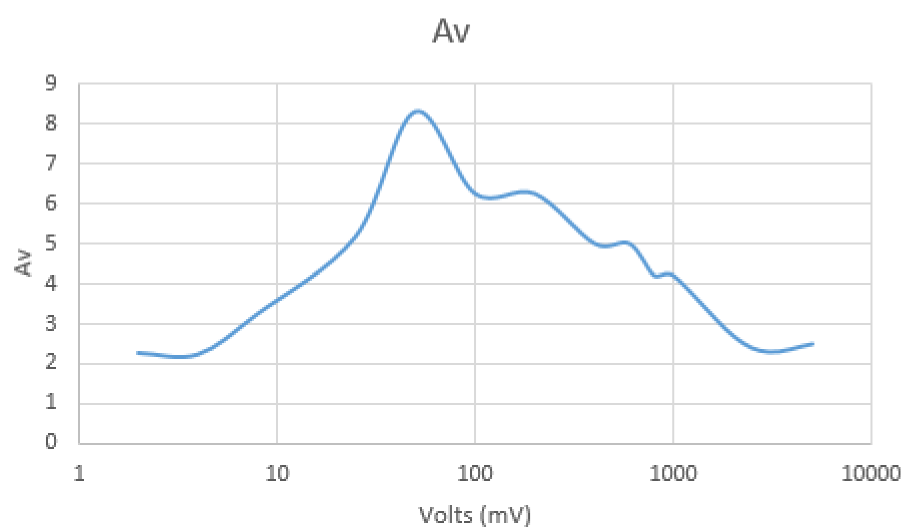
Mv	Av
2	2.275
4	2.237
8	3.25
25	5.175
50	8.3
100	6.25
200	6.25
400	5
600	5
800	4.2
1000	4.2
2000	2.7
3000	2.3
5000	2.5

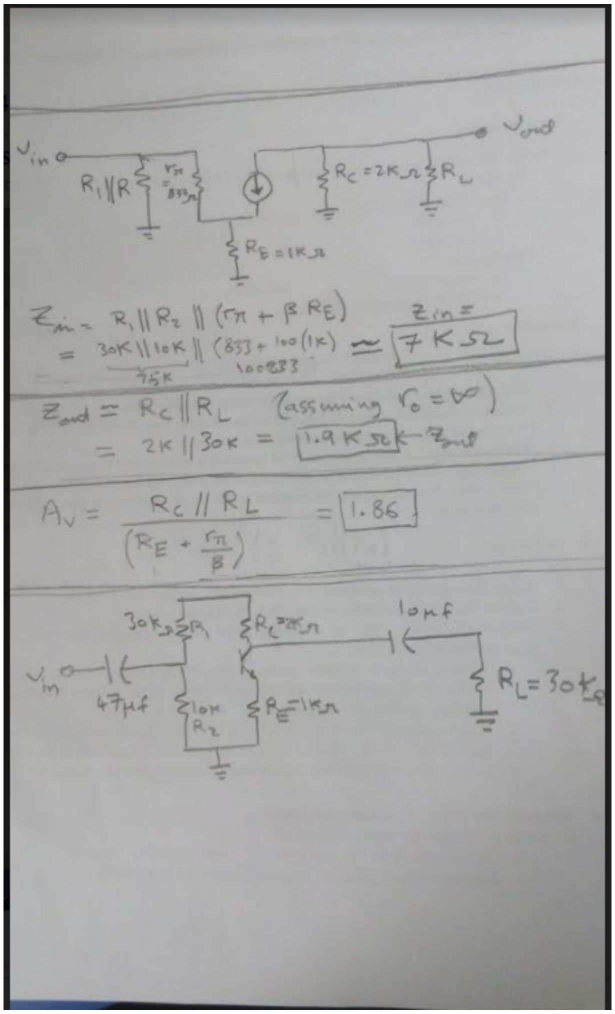


ANALYSIS

Comparer the calculations in prelab and experiments in experiment sections and briefly discuss the results and more spastically about

1. Av frequency response

Av response to frequency is very similar to the maximum gain achieved for the prelab. As the frequency increases, the gain increases until it reaches a certain frequency. At this point, the gain remains constant for a while, (equal to the calculated gain) and the gain beings to drop gradually as the frequency goes beyond a certain value.



2. Av versus input signal's amplitudes.

As the voltage increases, the gain increases until the ac voltage becomes so high that the bjt enters saturation mode. This causes the gain to plummet. The drop in gain in illustrated by the drop in the graph.

LAB VIDEO LINK: https://youtu.be/1jXS0RyUcpk

REPORT:

1. Call the TA to confirm the completion of your experiment

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2. Email the results using the computer of the Lab before leaving the lab.

LIST of RESISTOTS AND POTENTIOMETERS

POT 1K OHM 1/4W PLASTIC LINEAR
POT 10K OHM 1/4W PLASTIC LINEAR
POT 50K OHM 9MM SQ RTANG PLAST
POT 100K OHM THUMBWHEEL
RES 1 OHM 3W 5% AXIAL
RES 10 OHM 1 /2W 5% AXIAL
RES 56.2 OHM 1 / 4W 1% AXIAL
RES 100 OHM 1W 5% AXIAL
RES 200 OHM 1/4W 5% CARBON FILM
RES 499 OHM 1/4W 1% AXIAL
RES 1K OHM 1/4W 1% AXIAL
Res 1K, 1/4W

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RES 1.5K OHM 1/4W 5% CARBON FILM
RES 3.3K OHM 1/4W 5% CARBON FILM
RES 4.7K OHM 1 / 4W 5 AXIAL
RES 5K OHM 3W 5% AXIAL
RES 5.6K OHM 1/4W 5 AXIAL
RES 6.8K OHM 1/4W 5% AXIAL
RES 10K OHM 1/4W 5% CARBON FILM
Res 20K, 1/4W
RES 22K OHM 1/4W 5% AXIAL
RES 30K OHM 1/4 W 5% AXIAL
RES 33K OHM 1/2W 5% CF MINI
RES 39K OHM 2W 5% AXIAL
RES 49.9K OHM 1/4W 1% AXIAL
RES 68K OHM 2W 5% AXIAL
RES 100K OHM 1/2W 1% AXIAL
RES 200K OHM 2W 5% AXIAL
RES 332K OHM l / 4W 1% AXIAL
RES 500K OHM 1/4W 5% AXIAL
RES 1M OHM 1/2W 1% AXIAL
RES 10 M OHM 1/4W 5% AXIAL