Name: ____________________
Section: ____________________
Date: ____________________

EXPERIMENT 10

FREQUENCY RESPONSE OF A COMMON EMITTER AMPLIFIER

PURPOSE: The purpose of this experiment is to investigate the frequency response of a common emitter amplifier at the low and high range of frequencies. It will be shown that at the low range of frequencies the coupling and bypass capacitors affect the response while at the high end it is the load capacitor C_L. The effects of the individual coupling, bypass and load capacitors are investigated.

Preliminary Work

For practical reasons, the emitter bypass capacitor C_E is made to dominate the frequency response of the amplifier at the low range. C_E is designed to have the highest frequency break of all three capacitors while the break frequencies due to Cc_1 and Cc_2 are usually designed to be at much lower frequencies. (Why?). On the other hand, the load capacitor will limit the operation of the amplifier at high frequencies.

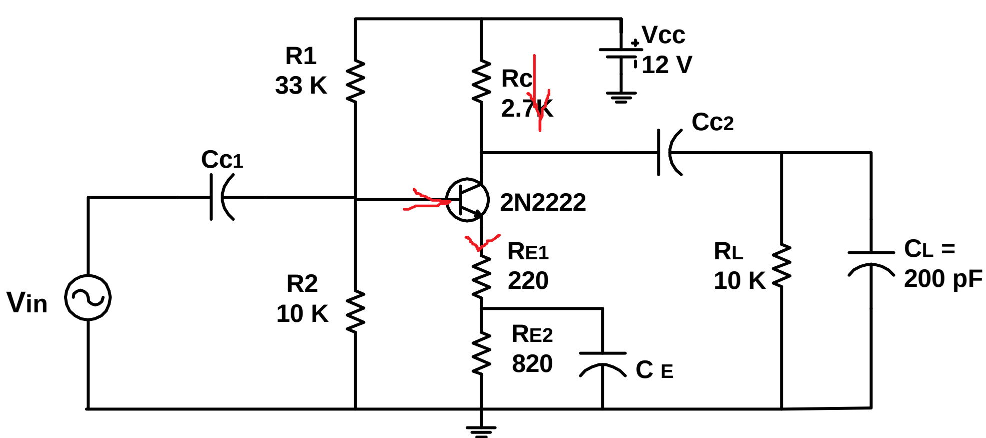


Figure 6.1 Common Emitter Amplifier
(With a Split Emitter Resistor)

1. <u>DC Analysis</u>

a) Calculate the Q-Point of the amplifier. Use the Q2N2222 with $V_{BE} = 0.7V$ and $\beta = 100$

I_E = ________ V_{RE} = ________ V_{RC} = ________ V_{CE} = ________

r_π = _______

b) Draw the ac model of the amplifier including all capacitors and find the mid-frequency voltage gain.

2. <u>The input coupling capacitor Cc_1 only</u>

a) Assuming that C_E acts as an open circuit while Cc_2 acts as short circuit, find the time constant and the low break frequency associated with the input coupling capacitor Cc_1.

b) Design Cc_1 to have a low break frequency of 50 Hz

Cc_1 = _________

3. <u>The output coupling capacitor Cc_2 only</u>

a) Again, assuming that C_E acts as an open circuit while Cc_1 acts as short circuit, find the time constant and the low break frequency associated with the output coupling capacitor Cc_2.

b) Design Cc_2 to have a low break frequency of 100 Hz

Cc_2 = _________

4. <u>The bypass capacitor C_E only</u>

a) This time assume that Cc_1 and Cc_2 act as short circuits and find the zero and pole frequencies associated with C_E.

b) Design C_E to have a low break frequency of 1KHz

C_E = _________

4. <u>The load capacitor C_L only</u>

If the load capacitor is C_L = 100pF, find the high break frequency of the amplifier.

f_H = _________

5. Pspice

In order to verify your design and see the effects of each capacitor, one needs to simulate the circuit in Figure 6.1 with some modifications, each tailored for the capacitor in question. For each case below, run an ac sweep from 1Hz to 1MHz (decade, with 10 points per decade will do the job)

a) **For the input coupling capacitor Cc_1 only:** do not include the bypass capacitor C_E and set Cc_2 to a very large value (50µF).

Pspice's break frequency = ? ________

b) **For the output coupling capacitor Cc_2 only:** do not include the bypass capacitor C_E and set Cc_1 to a very large value (50µF).

Pspice's break frequency = ? ________

c) **For the bypass capacitor C_E only:** set Cc_1 and Cc_2 to a very large values (50µF).

Pspice's break frequency = ? ________

d) **Total frequency response:** set all capacitor values to the designed ones and see the overall frequency response.

Pspice's low break frequency = ? ________
Pspice's high break frequency = ? ________

BW = _________

Compare you calculated results vs. the Pspice results. Comment on the individual break frequencies as well as the mid-frequency gain.

DC Measurements: Set up the circuit in Figure 6.2. (The shown circuit includes only the DC portion of the amplifier). Measure each component value before inserting in the circuit and record their values in the place indicated.

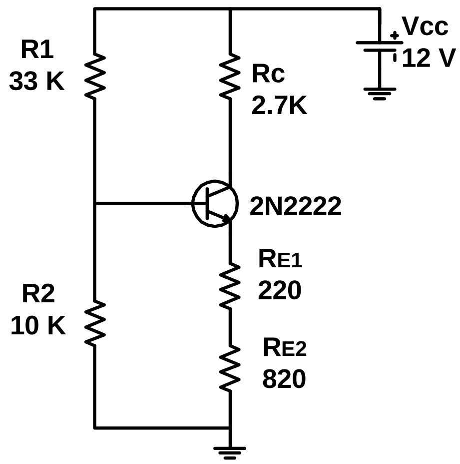


Figure 6.2 Common Emitter Amplifier – DC part

Measure: R_c = 2.66K R_{E1} = 222.67 R_{E2} = 809 R_1 = 32.27K R_2 = 9.67K

V_{CE} = 4.74K V_E = 1.997V

Calculate: I_E = VE/RE

The results above should be close to the calculated and simulated values. There is no need to fine tune components to give the exact vales of V_{CE} and I_E. Fine tuning is needed only for large variations in the Q – Point compared to the theoretical values.

AC Measurements:

General:

As was done in the preliminary work for the Pspice simulation, the experiment itself will be broken to several parts, each tailored to find the break frequency of a particular capacitor. In order to find the break frequency due to a particular capacitor:

a) Set the signal generator to some high frequency (5KHz) and vary the signal generator's voltage such that the output of the amplifier is adjusted to a convenient level (For example 1V or 2V). Record Vout at this frequency as Vout_max

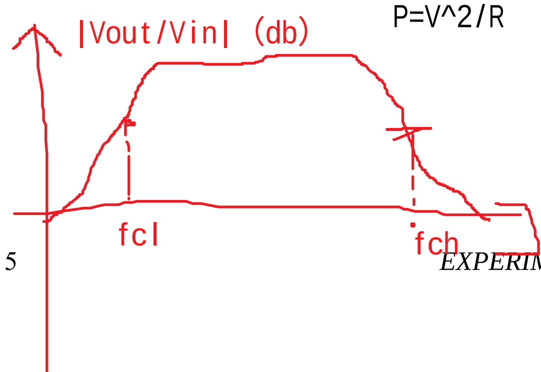
b) Decrease the signal generator's frequency to a frequency that output voltage drops to 70.7% of its value. This frequency is the break frequency due to the capacitor in question. Record this frequency.

b)we decrease the frequency so that Vout drops to Vout_max/sqrt(2),this frequency is called the break frequency or cutoff frequency

1/sqrt(2)=70.7%

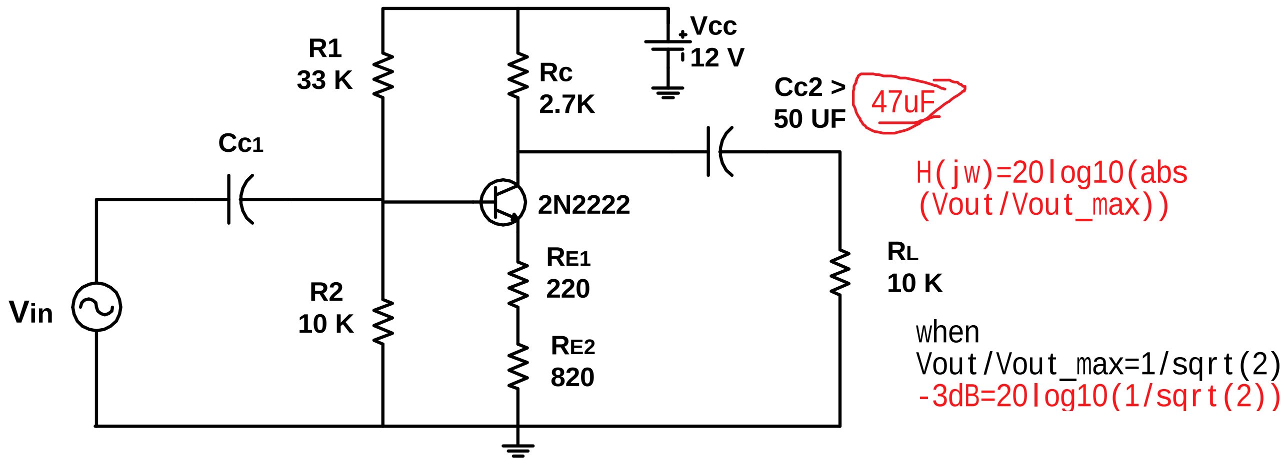
Pout=0.5*Pin
fc: Vout=(1/sqrt(2))*Vin

P=V^2/R



AC Measurements / Continue

1) **Input coupling capacitor Cc_1:** do not include the bypass capacitor C_E and use for Cc_2 a very large capacitor (50µF). **For Cc_1 use a capacitor as close as possible to the designed one!**

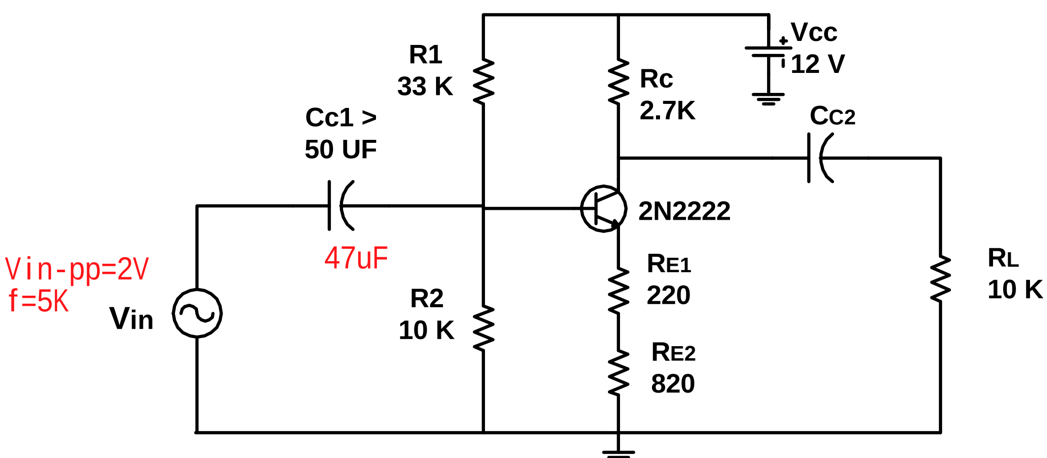


0.494uF

Vout/Vout_max=1/sqrt(2)

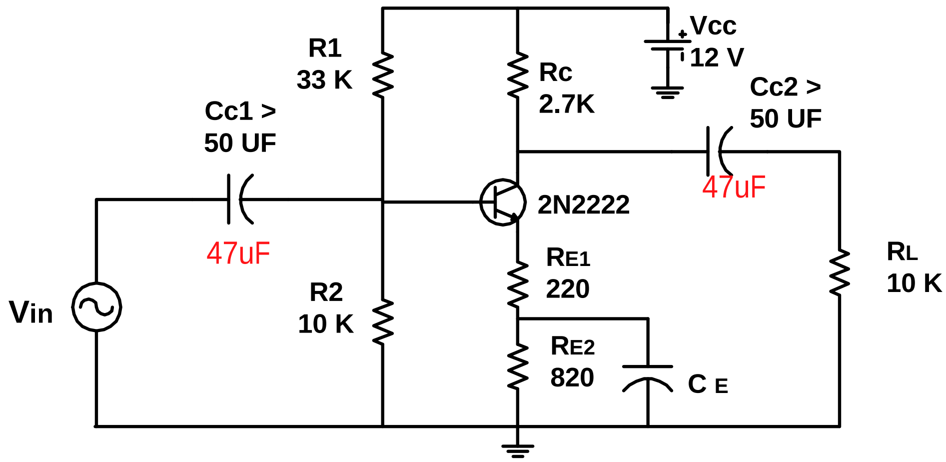
Cc_1 = 470nF **f_L** = ______ **Pspice's break frequency** = ________

2) **Output coupling capacitor Cc_2:** do not include the bypass capacitor C_E and use for Cc_1 a very large capacitor (50µF). **For Cc_2 use a capacitor as close as possible to the designed one!**



Cc_2 = 99nF **R_L** = 10K **f_L** = ______ **Pspice's break frequency** = ________

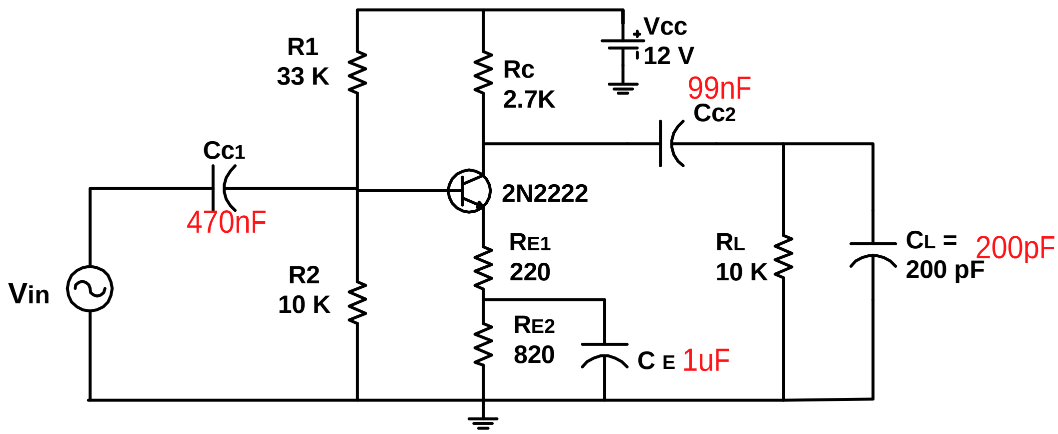
3) Bypass capacitor C_E: Use large capacitors for Cc_1 and Cc_2 (50µF). **For C_E use a capacitor as close as possible to the designed one!**



C_E = 1uF____ **f_L** = ______ **Pspice's break frequency** = ________

4) **Total frequency response:** set all capacitor values to the designed ones and record the overall frequency response. Make sure you find also the exact f_H of the amplifier.

C_L = 200pF



Freq. (Hz)	10	50	100	500	1 k	5 k	10 k	100 k	300 k	550 k	800 k
v_{outpp} (V)											
v_{inpp} (V)											
A_V											
$(A_V)_{dB}$											

Discussion of the Results

1. Comment on the results obtained regarding:
   a) Q- Point
   b) Voltage gain
   b) Break frequencies
2. Plot $(A_V)_{dBs}$ vs f on **semi-log** paper.
3. Why the emitter bypass capacitor C_E is made to dominate the frequency response of the amplifier at the low range.
4. Write a conclusion.