Analog Electronics

Laboratory work

Amplifier low frequency response

Key objective

1. Compute and measure the three lower critical frequencies for a CE amplifier and use them to compute the overall lower critical frequency, then measure it.

Components needed

- Resistors: one 10 Ω, one 47 Ω, one 560 Ω, one 1 kΩ, one 3.9 kΩ, two 10 kΩ, one 68 Ω
- One BC140 npn transistor
- Capacitors: one 0.22 uF, one 1.0 uF, one 100 uF

Low Frequency Response

1. Compute the ac and dc parameters listed in Table 1 for the CE amplifier shown in Figure 1. R_A and R_B are not part of the amplifier but are only included as an input attenuator that will provide a 20 mV_{PP} signal to the input (V_{in}). Tabulate your calculations in Table 1.

Table 1

Parameter	Computed value	Measured value
V_B		
V_E		
I_E		
V_C		
V_{CE}		
r_e		
A_V		
V_{out}		

2. Construct the amplifier shown in Figure 1. Then measure and record the parameters listed in Table 1 and confirm your calculations. You can assume the input signal is 20 mV_{PP}, which is difficult to measure accurately, if the signal generator is confirmed to be 450 mV_{PP}.

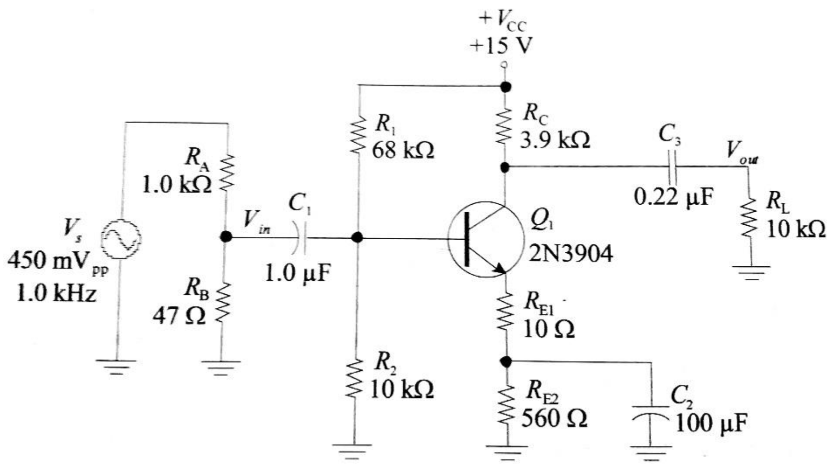

Figure 1

3. To compute the lower frequency response, it is necessary to find the equivalent resistance that represents the ac charge and discharge path for each capacitor. See Thomas Floyd: Electronic devices page 512-530 to compute equivalent resistances seen by each capacitor. Enter the computed value in Table 2.

Table 2

Capacitor	R_{eq}
C_1	
C_2	
C_3	

4. Compute the lower critical frequency for each capacitor from the equation:

$$f = \frac{1}{2\pi R_{eq} C}$$

Use the R_{eq} from Table 2 for each capacitor. Enter the computed lower critical frequency for each capacitor in Table 3. The overall critical frequency of amplifier will be higher than the highest frequency determined for each individual capacitor. To obtain a rough estimate of upper cutoff, you can simply add the three critical frequencies; the actual frequency will be lower that this estimate. Enter the estimated overall frequency in Table 3 below.

Capacitor	$f_{critical}$
C_1	
C_2	
C_3	
Overall	

5. To measure the critical frequency due to C_1, you need to isolate this capacitor by “swamping” out the effect of C_2 and C_3. Place a 1000 uF capacitor across C_2 and another 1000 uF capacitor across C_3; this causes their frequency response to have little effect on the output. Observe the signal in midband (around 10 kHz) and adjust the signal for 5.0 vertical divisions on the scope face. The output should appear undistorted. Reduce the generator frequency until the output falls to 70.7% (approximately 3.5 divisions) of the voltage in midband. This frequency is the lower critical frequency due to C_1. Measure and record the value in Table 3.
6. Using the 1000 uF capacitors, isolate C_2 by placing large capacitors in parallel with C_1 and C_3. Measure and record the critical frequency for C_2 in Table 3.
7. Measure the critical frequency for C_3 by the same method. Record the value in Table 3.
8. Remove the large capacitors and measure the overall critical frequency of the amplifier. Record the value in Table 3.
9. Assume you need to raise the lower critical frequency to 300 Hz. Calculate the value of a bypass capacitor, C_2, for the circuit in Figure 1 that will accomplish this.
10. What change would you make to the circuit to lower the frequency response in the CE in Figure 1 by a factor of five?