CET 323 LAB

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Class CET 323_01

LAB_03_B

Amplifiers Low-Frequency Response

Reading

Floyd, Electronic Devices, Ninth Edition, Chapter 10.

Key Objectives

Part 1 : Compute and measure the three critical frequencies for a CE amplifier and use them to compute the overall lower frequency, f_{cl} ; then measure f_c .

Components needed

Part 1 :Low-Frequency Response.

Resistor : One 10 Ω , one 47 kΩ , one 560 Ω , one 1.0 kΩ , one 3.9 kΩ , two 10 kΩ, one 68 kΩ

One **2N3904** ***npn*** transistor.

Capacitors : One 0.22 μF , one 1.0 μF , one 100 μF, two 1 000 μF, one to be determined by student.

Part 1 :Low-Frequency Response.

1. Measure and record the values of the resistor listed in the Table 10_1. You will use the same resistors in part 2, so it will not be necessary to measure them again.

Table 10_1

Resistor	Listed Value	Measured Value
R_A	1.0 kΩ	
R_B	47 Ω	
R_1	68 kΩ	
R_2	10 kΩ	
R_{E1}	10 Ω	
R_{E2}	560 Ω	
R_C	3.9 kΩ	
R_L	10 kΩ	

2. Compute the ac and dc parameter listed in Table 10_2 for the CE amplifier shown in Figure 10_1. R_A and R_B are not part of the Amplifier but are only included as an input attenuator in Table 10_2.(the first five are dc parameter's; the last three are ac parameters).

3. Construct the amplifier shown in Figure 10_1. Then measure and record the parameters listed table 10_2 and confirm your calculation. You can assume the input signal is 20mVpp, which is difficult to measure accurately, if the signal generator is confirmed to be 450 mVpp

4. To compute the low- frequency response, it is necessary to find the equivalent resistance, R_{eq}, that represents the ac charge and discharge path for each capacitor Tracing the path for C_1, you see the path to ground as illustrated in Figure 10_2 with the dotted lines.(Recall that the power supply is an ac ground.) On the right side of C_1 are the bias resistor (R_1 and R_2) and the ac resistance of the emitter circuit consisting of R_{E1} + r_e. Together, these resistors are equivalent to a single resistance, R_{in}, On the left side of C_1, are two paths - the series combination of (R_A \ R_{th}) is in parallel with R_B. Thus, to total equivalent resistance for C_1 is :

$$R_{eq} = R_{in} + (R_A + R_{th}) \backslash\backslash R_B$$

$$= \beta_{ac} (R_{E1} + r_C) \backslash\backslash R_1 \backslash\backslash R_2 + (R_A + R_{th}) \backslash\backslash R_B$$

Using this equation, compute the equivalent resistance seen by C_1 . It is useful if you know the β_{ac} for your transistor;

If you do not know it, you can assume a typical value 200. Enter computed value in Table 10_3.

Table 10_03

Capacitor	Req
C1	2.936 kΩ
C2	0.021 kΩ
C3	13.905 kΩ

Compute :

(a) For C_1, on the right side of C_1 are the bias resistor (R_1 // R_2) and the ac resistance of the emitter circuit consisting of R_{E1} + re. Together, these resistors are equivalent to a single resistance, Rin, on the left side of C_1, are two paths - the series combination of (R_A \ R_{th}) is in parallel with R_B. Thus, to total equivalent resistance for C_1 is:

$$R_{eq} = R_{in} + (R_A + R_{th}) \setminus\setminus R_B$$

$$= \beta_{ac} (R_{E1} + r_C) \setminus\setminus R_1 \setminus\setminus R_2 + (R_A + R_{th}) \setminus\setminus R_B$$

R_{eq1} =

$$\boxed{R_{eq2} = 2.936\ k\Omega}$$

(b) For C_2, R_{E1} is in parallel with the capacitor and combination or R_{E2} and r_e , and the reflected resistance of the base circuit. (The reflected resistance of the base circuit is only 4 Ω to 6 Ω because it is divided by β to move it to the emitter circuit.) , thus C2 // (R_{E1} \ R_{E2} \ r_e) => we have formula of the equivalent resistance, R_{eq} of C_2 is :

R_{eq2} =

⇨ $\boxed{R_{eq2} = 0.021\ k\Omega}$

(c) For C_3, the collector resistance appears to be in series with the load resistance, thus C_3 \ R_L \ R_c => we have formula of the equivalent resistance, R_{eq} of C_3 is :

$$R_{eq3} = (R_C + R_L) = 3.9\ k\Omega + 10\ k\Omega = \mathbf{13.9\ k\Omega}$$

⇨ $\boxed{R_{eq3} = 13.905\ k\Omega}$

5. In the same manner as in step 4, you can trace the charge/discharge path for C_2 and C_3. For C_2, R_{E1} is in parallel with the capacitor and combination or R_{E2} and r_e , and the reflected resistance of the base circuit. (The reflected resistance of the base circuit is only 4 Ω to 6 Ω because it is divided by β to move it to the emitter circuit.) Note that for C3, the collector resistance appears to be in series with the load resistance. Compute the equivalent resistance seen by C2 and C3 . Enter the computed values in table 10_3.

6. Compute the lower critical frequency for each capacitor (C_1, C_2 and C_3) from the equation:

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

Use the Req from table 10_3 for each capacitor. Enter computed lower critical frequency for each capacitor in table 10_4. The overall critical frequency of the amplifier will be higher than the highest frequency determined for each individual capacitor. To obtain a rough estimate of the upper cutoff, you can simply add the three critical frequencies; the actual frequency will be lower than this estimate. Enter the estimated overall frequency in table 10_4.

7. To measure the critical frequency due to C1, you need to isolate this capacitor buy "**swamping**" out the effect of C2 and C3. Place a 1 000 μF capacitor across C3; this causes their frequency response to have little effect on the output. Observe the output signal in midland (around 10kHz) 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 the table 10_4.

8. Using the 1 000 μF capacitor, isolate C_2 by placing the large capacitor in parallel with C_1 and C_3. Measure and record the critical frequency for C_2 in table 10_4.

9. Measure the critical frequency for C_3 by the same method. Record the value in table 10_4.

10. Remove the large capacitor and measure the overall critical frequency of the amplifier. Record the value in table 10_4.

Table 10_4

Capacitor	fcritical	
	Computed	Measured
C_1	54.23 Hz	44.2 Hz
C_2	75.60 Hz	71.8 Hz
C_3	52.05 Hz	52.4 Hz
Overall	181.88 Hz	168.4 Hz

Computed :

(a) - Compute for frequency for Capacitor one :

$$\mathbf{f_{cC_1}} = \frac{1}{2\pi R_{eq1} C_1} = \frac{1}{2\pi\,(2.936\ \mathrm{k\Omega})(1\ \mu\mathrm{F})} = 0.05423\ \mathrm{kHz} = 54.23\ \mathrm{Hz}$$

⇨ $\boxed{f_{CC1} = 54.23\ \mathrm{Hz}}$

(b)- Compute for frequency for Capacitor two :

⇨ $$\mathbf{f_{cC_2}} = \frac{1}{2\pi R_{eq2} C_2} = \frac{1}{2\pi\ (0.021\ \text{k}\Omega)(100\ \mu\text{F})} = 0.07582\ \text{kHz} = 75.82\ \text{Hz}$$

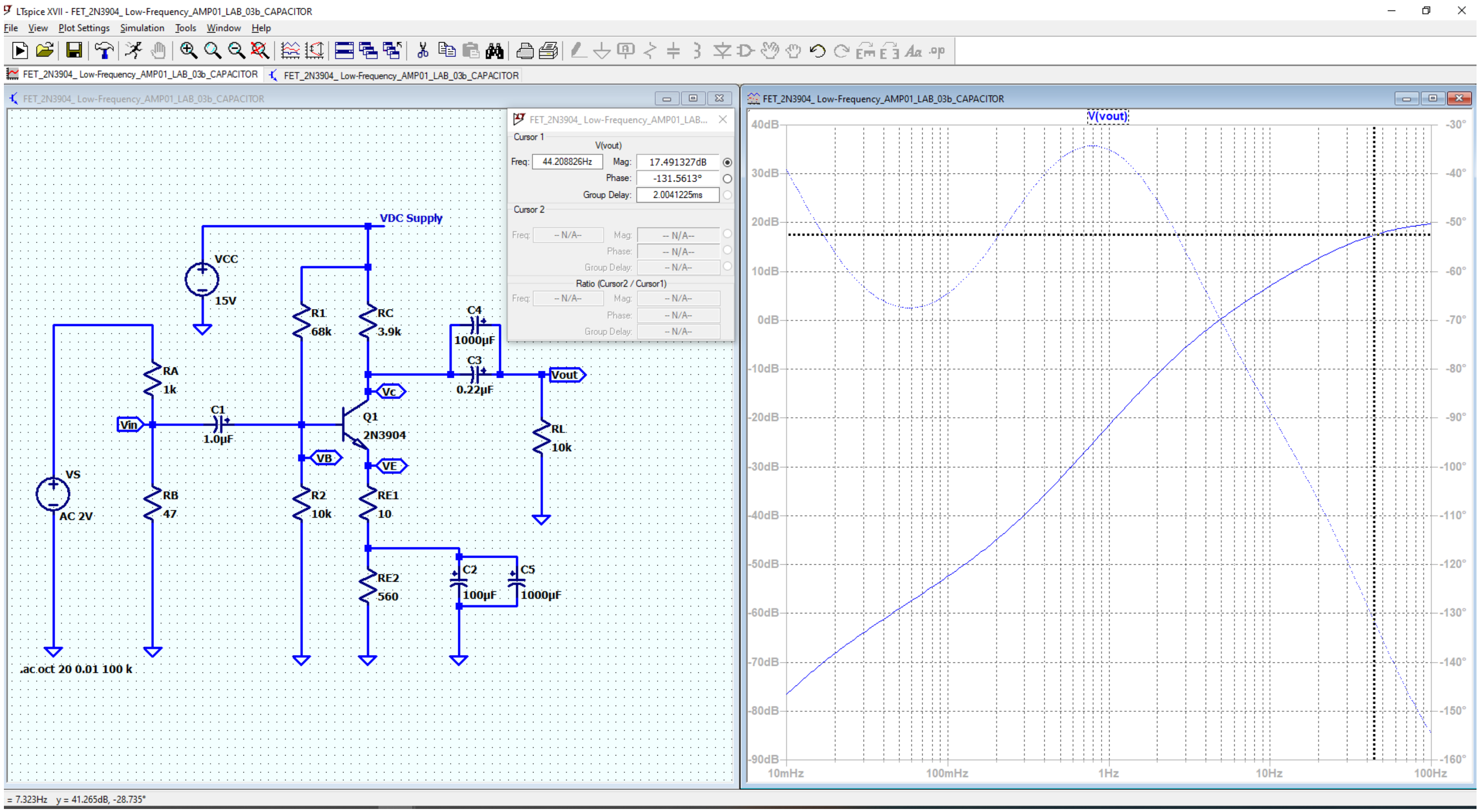
⇨ $$\boxed{\mathbf{f_{CC2} = 75.82\ Hz}}$$

(c) - Compute for frequency for Capacitor one :

⇨ $$\mathbf{f_{cC_3}} = \frac{1}{2\pi R_{eq3} C_3} = \frac{1}{2\pi\ (13.905\ \text{k}\Omega)(0.22\ \mu\text{F})} = 0.05205\ \text{kHz} = 52.05\ \text{Hz}$$

⇨ $$\boxed{\mathbf{f_{CC3} = 52.05\ Hz}}$$

Measured for Capacitor one (C_1 = 44.2 Hz)



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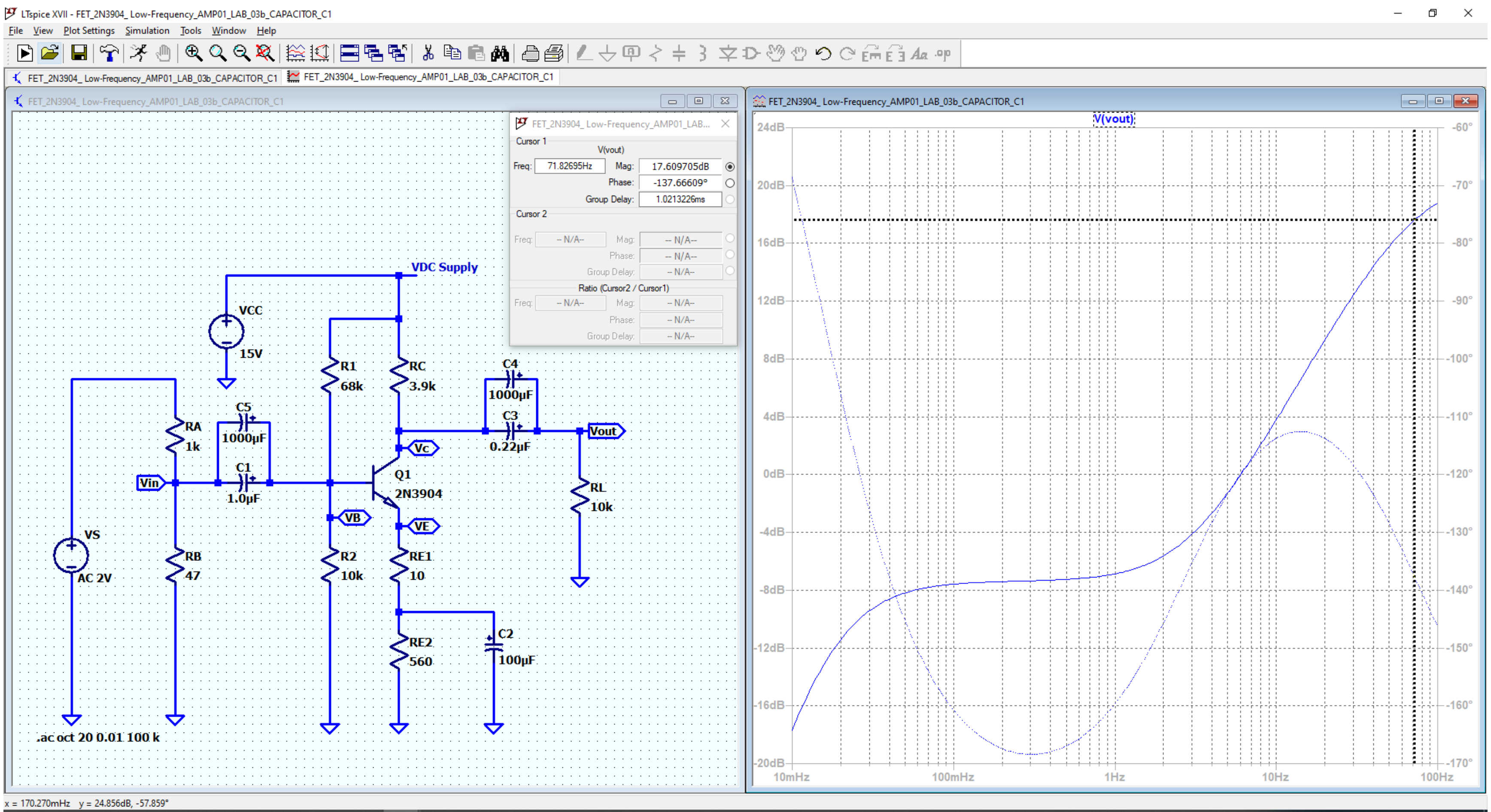
Measured for Capacitor two (C_2 = 71.7 Hz)



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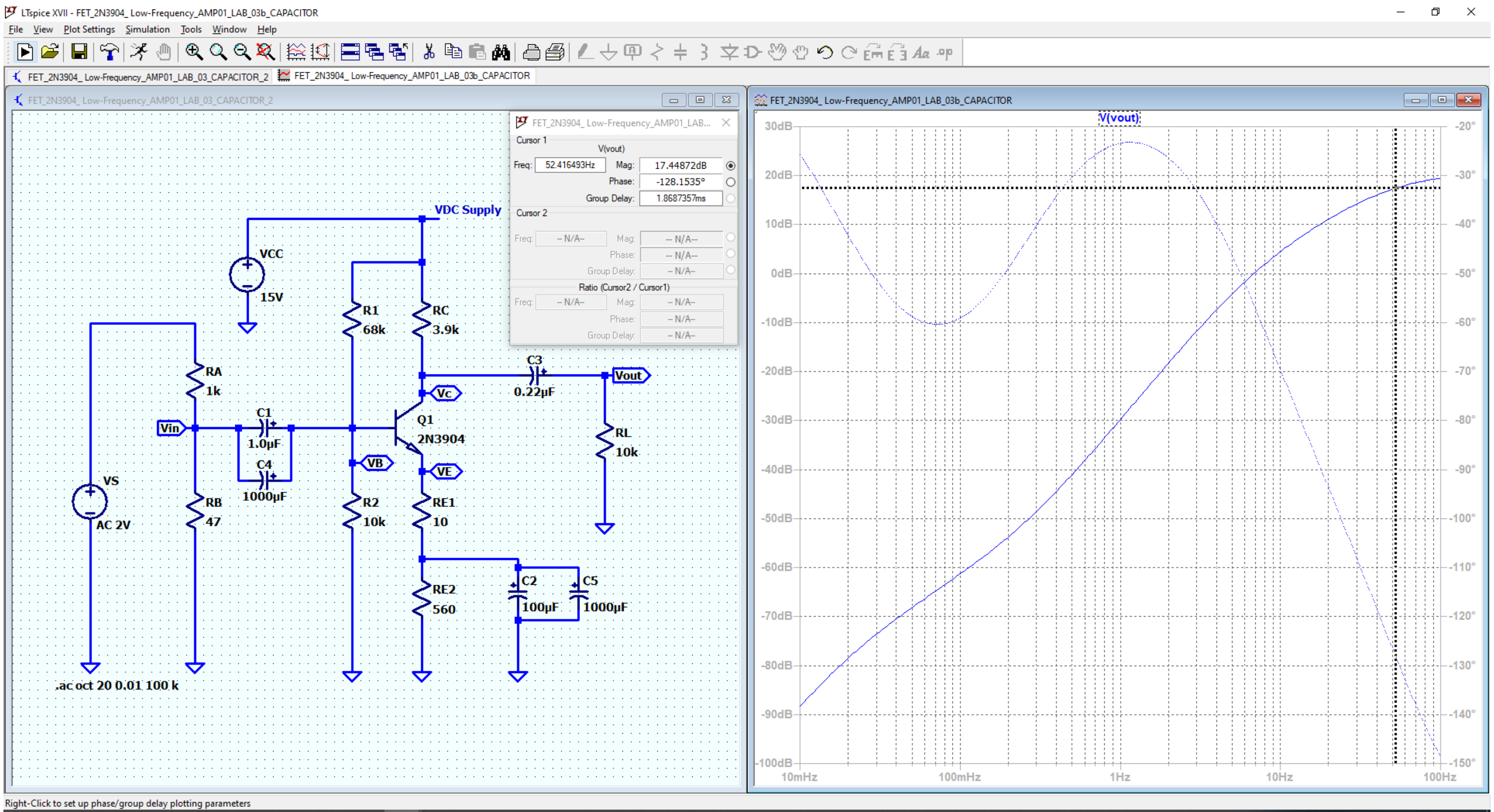
Measured for Capacitor three (C_3 = 52.4 Hz)



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Measured for three Capacitors overall ($C_1 + C_2 + C_3 = 168$ Hz)