ECE 214 - Lab #10
Thévenin Equivalent Circuits

22 April 2019

Introduction: In this lab, you will analyze and measure the Thévenin equivalent input impedance and the voltage gain, for both a common emitter amplifier, and a common emitter amplifier with emitter degeneration resistance.

The common emitter amplifier circuit is shown in Figure 1(a). This circuit incorporates a 2N2222 NPN bipolar junction transistor (BJT) for amplification. An equivalent small-signal circuit model is shown in Figure 1(b).

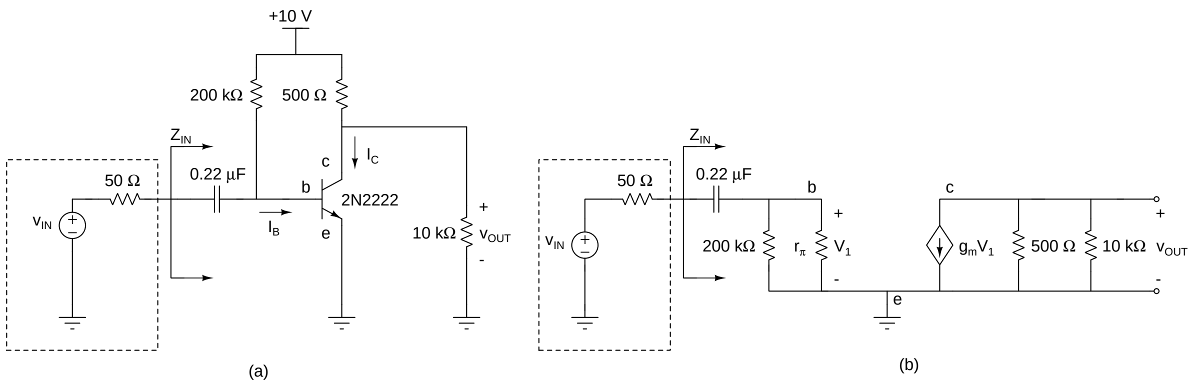

Figure 1: (a) Common emitter amplifier circuit, and (b) equivalent low frequency small-signal circuit model.

A modified common emitter amplifier circuit with emitter degeneration resistance is shown in Figure 2(a). This circuit incorporates a 20 Ω resistor between the emitter and ground. The low frequency equivalent small signal circuit model is shown in Figure 2(b).

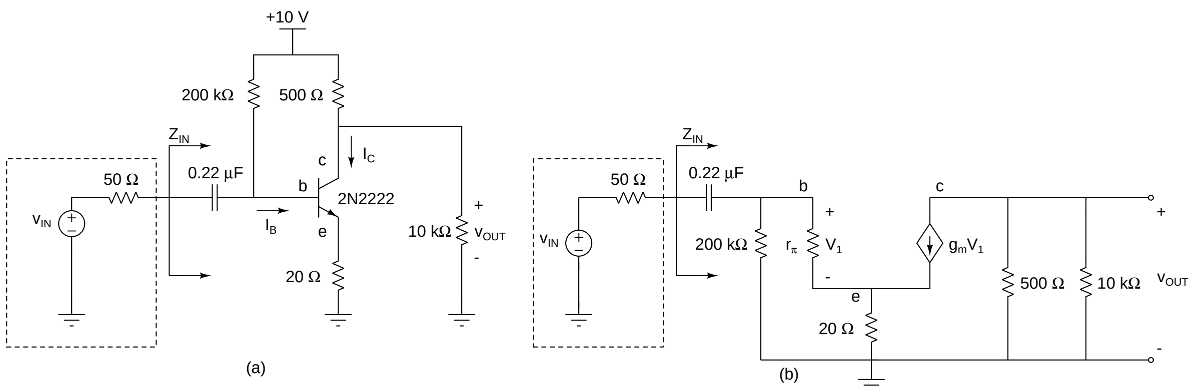

Figure 2: (a) Common emitter amplifier circuit with a 20 Ω emitter degeneration resistor, and (b) equivalent low frequency small-signal circuit model.

Pre-Lab:

1. For the circuit shown in Figures 1(b) and 2(b), calculate:

   (a) the voltage gain (v_{OUT}/v_{IN}), and

   (b) the Thévenin equivalent input impedance (Z_{IN})

   in terms of the transistor input resistance (r_π) and transconductance (g_m). Assume the input signal has a frequency of 5 kHz. Complete Table 1 below:

Table 1: Voltage gain and Thévenin input resistance in terms of the parameters r_π and g_m.

	Amplifier (Figure 1)	Amplifier (Figure 2)
v_{OUT}/v_{IN}		
Z_{IN}		

2. For the circuit in Figure 1, devise an experiment to measure the DC currents I_C and I_B.

Lab Procedure:

1. Build the circuit shown in Figure 1.
2. Measure the DC current I_C in mA. Calculate the transconductance: $g_m = 38.6 \times I_C$ mA/V.
3. Measure the DC current I_B in mA. Calculate the current gain $\beta = I_C/I_B$ and $r_\pi = \beta/g_m$ kΩ.
4. Using the values of r_π and g_m determined above, calculate the expected voltage gain and Thévenin equivalent input impedance. Complete Table 2 below:

Table 2: Expected voltage gain and Thévenin input resistance based on the determined values of r_π and g_m.

	Amplifier (Figure 1)	Amplifier (Figure 2)
v_{OUT}/v_{IN}		
Z_{IN}		

5. Set input source to generate a sine wave with an amplitude of 20 mV and a frequency of 5 kHz.
6. Measure the voltage gain (v_{OUT}/v_{IN}) and Thévenin equivalent input impedance (Z_{IN}).
7. Build the circuit shown in Figure 2.
8. Measure the voltage gain (v_{OUT}/v_{IN}) and Thévenin equivalent input impedance (Z_{IN}).
9. Complete Table 3 below:

Table 3: Measured voltage gain and Thévenin input impedance

	Amplifier (Figure 1)	**Amplifier (Figure 2)**
v_{OUT}/v_{IN}		
Z_{IN}		

Post-Lab: For the two amplifier circuits, compare the expected voltage gain and Thévenin input impedance to the measured values. Are the small-signal models a good representation of the actual circuits?