ELEC-313
Lab 1: Amplifier Models

September 18, 2013

Date Performed:	September 11, 2013
Partners:	Charles Pittman
	Stephen Wilson

1 Objective

The objective is to verify the equivalence of four circuits used to model an amplifier, shown in Figure 3.

2 Schematics

Circuit Tested

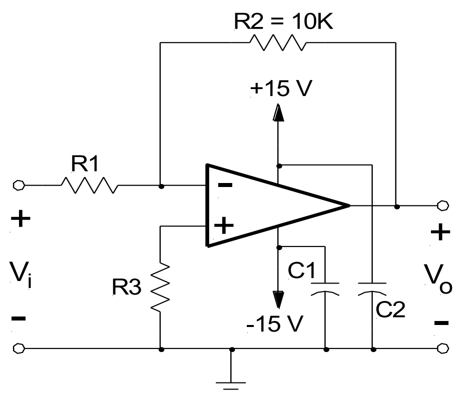

Figure 1: Circuit being tested. $C_1 = C_2 = 1\,\mu\text{F}$

Test Configuration

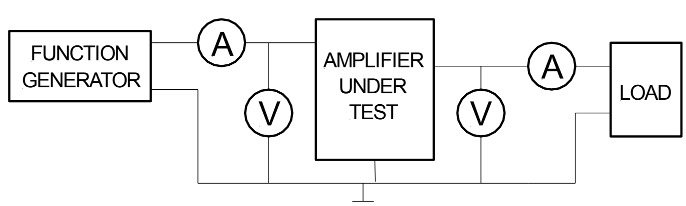

Figure 2: Test Configuration

3 Procedure

First, resistors R_1, R_2, and R_3 were measured with a multimeter and recorded in Table 1. Then the circuit in Figure 1 was constructed on a breadboard. Next, the configuration depicted in Figure 2 was assembled.

Two Fluke multimeters served as the ammeters, and two input channels of an oscilloscope served as voltmeters. The function generator was set to produce a sine wave with amplitude of $200\,\mathrm{mV_{rms}}$ @ $1\,\mathrm{kHz}$, serving as the voltage source, and a decade box set to $200\,\Omega$ serving as the load.

With the load disconnected, the input voltage (V_i), input current (I_i), output voltage (V_o), and output current (I_i) were measured and recorded in Table 2. This step was then repeated with the load connected. Using these values with the equations derived from the four amplifier models, measured values were determined where direct measurement was difficult.

4 Results

Name	**Nominal** (kΩ)	**Measured** (kΩ)	**% Error**
R_1	1	0.986	1.40
R_2	10	9.88	1.20
R_3	1	0.983	1.70

Table 1: Comparison of labelled and actual resistance.

	Voltage		**Current**	
	V_i ($\mathrm{mV_{rms}}$)	V_o ($\mathrm{V_{rms}}$)	I_i ($\mathrm{mA_{rms}}$)	I_o ($\mathrm{mA_{rms}}$)
No Load	200	1.98	0.2	nil
Load	200	1.98	0.2	9.52

Table 2: Comparison of electrical characteristics of the amplifier under load.

	Load			**No Load**	
	Nominal	**Measured**	**% Error**	**Nominal**	**Measured**
R_o (Ω)	0	0	nil	0	0
R_i (kΩ)	1	1	0.00%	1	1
A_v	10	9.9	1.00%	10	9.9
A_i	50	47.6	4.80%	nil	nil
G_m (S)	∞	∞	nil	∞	∞
R_m (kΩ)	10	9.9	1.00%	10	9.90

Table 3: Comparison of values determined from amplifier models in Figure 3

5 Conclusion

As shown in Table 3, the amplifier models do closely represent the amplifier used in the experiment. The greatest difference occurred in the current gain (A_i), largely due to R_o being nearly zero. This also causes G_m to be very large.

6 Appendix

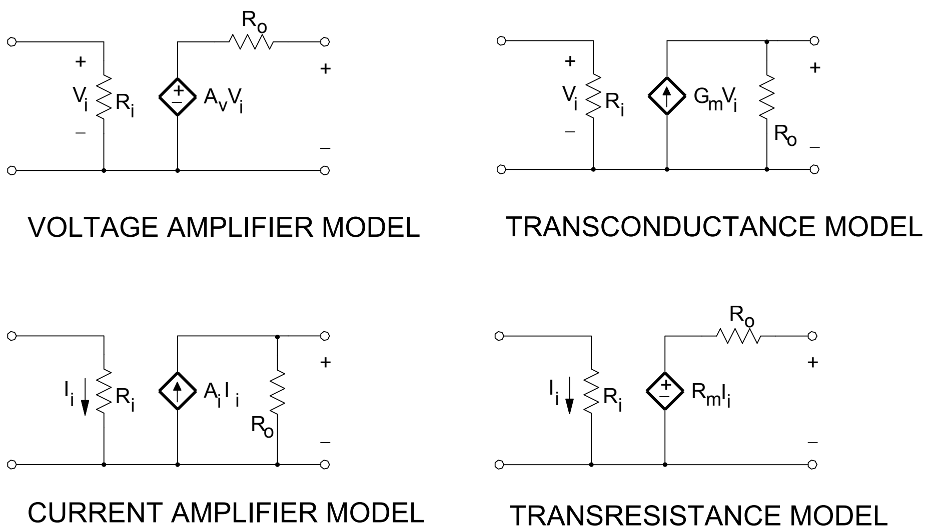

Figure 3: Four equivalent models of an amplifier

Equations

$$\%_{error} = \frac{|measured - nominal|}{nominal} \times 100\% \tag{1}$$

$$R_o = \frac{V_{noload} - V_{load}}{I_{load}} \tag{2}$$

$$R_i = \frac{V_i}{I_i} \tag{3}$$

$$A_v = \frac{V_o}{V_i} \tag{4}$$

$$A_i = A_v \left(\frac{R_i}{R_o} \right) \tag{5}$$

$$G_m = \frac{A_v}{R_o} \tag{6}$$

$$R_m = A_v R_i \tag{7}$$