

ELEC 313 Lab 1
Amplifier Models

REFERENCE: Appropriate chapters of ELEC 306 text.

OBJECTIVE: The objective of this experiment is to compare and contrast four amplifier models using an operational amplifier circuit.

EQUIPMENT: LM741 Op Amp
Resistors R_1, R_2, R_3
Capacitors C_1, C_2
Resistive decade box
Power Supply (Vdc), Multi Meter, Function Generator, Oscilloscope

INTRODUCTION:*Models*

A linear amplifier can be modeled with any one of the four equivalent circuits.

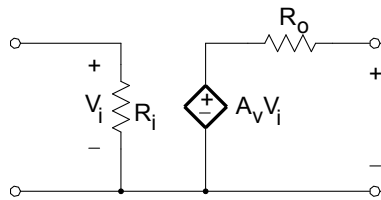
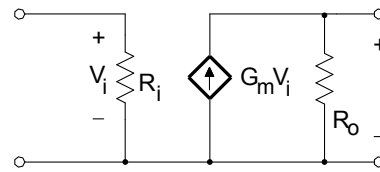
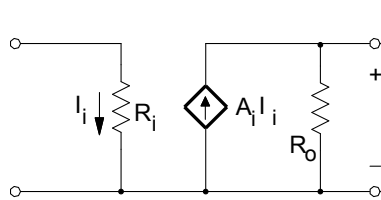
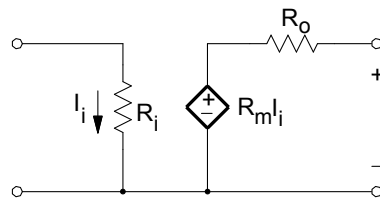
**VOLTAGE AMPLIFIER MODEL****TRANSCONDUCTANCE MODEL****CURRENT AMPLIFIER MODEL****TRANSRESISTANCE MODEL**

Figure 1: Four amplifier models.

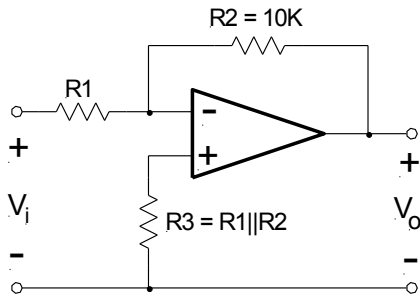
PRIOR PREPARATION (Pre-Lab):

Complete the following at a time determined by the laboratory instructor.

Given the parameters of the first model, R_i , R_o , and A_v , determine formulas for G_m , R_m , and A_i in terms of the given parameters.

Amplifier design

Compute resistor value R_1 to give the circuit below a voltage gain of $(-x)$.



The variable x may vary among lab teams and will be provided by the instructor. Unless directed otherwise let $x = 10$.

Round resistor value R_1 (if necessary) to the nearest value in the standard 12-point logarithmic sequence shown in table 1. Using the rounded value of R_1 , compute R_3 and round its value accordingly.

1K	1.2K	1.5K	1.8K	2.2K	2.7K	3.3K	3.9K	4.7K	5.6K	6.8K	8.2K
10K	12K	15K	18K	22K	27K	33K	39K	47K	56K	68K	82K
100K	120K	150K	180K	220K	270K	330K	390K	470K	560K	680K	820K

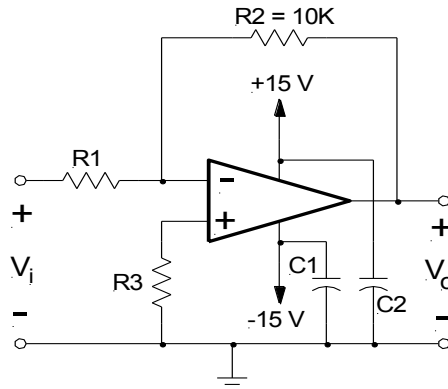
Table 1. Resistor values

Product information

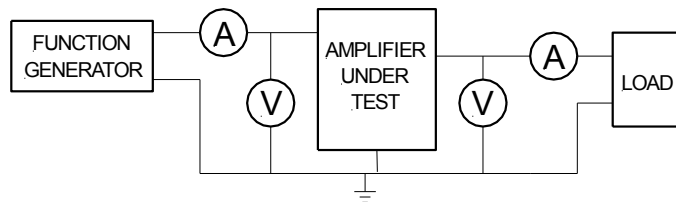
Enter the National Semiconductor website, www.national.com, and retrieve the data sheet for a LM741 op-amp. Print out the pages that show the package connection diagrams, the absolute maximum ratings, and the electrical characteristics.

PROCEDURE:

1. Obtain the resistors, capacitors, and op-amp needed to build the following circuit based on your design. $C_1 = C_2 = 1\mu\text{F}$.



2. Measure the resistors with the multimeter, record their values, and compute %error from nominal.
3. Build the circuit on a breadboard.
4. Turn on a function generator, set its frequency to 1 kHz, and select a sine wave.
5. Connect the test configuration as shown. Use Fluke multimeters for the ammeters and the oscilloscope for the voltmeters. Leave the load open-circuited for now.



6. Adjust the amplitude of the function generator for **200 mV_{rms}** at the input to the amplifier *as measured on the oscilloscope*.
7. Measure the input voltage and current as well as the output voltage in this open-circuit case. Note: the multimeter measures rms current; thus, the voltage measurement on the oscilloscope should also be in terms of rms.
8. Connect the decade resistor box as the load and set its value to **200 Ω** .
9. Measure the output voltage under this load.

Data Analysis

- 1) Compute the input resistance from

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

- 2) Compute the output resistance from

$$R_o = \frac{V_{no\text{load}} - V_{load}}{I_{load}}$$

- 3) Compute the voltage gain of the amplifier in both the unloaded and loaded cases using the measured data.
- 4) Compute the current gain of the amplifier with the load using the measured data.
- 5) Using the formula developed in pre-lab, compute the transconductance by transforming the voltage gain data obtained in the unloaded case.
- 6) Using the formula developed in pre-lab, compute the transresistance by transforming the voltage gain data obtained in the unloaded case.

LAB REPORT:

Your report should be completed in the format requested by the instructor. Specifically, it must contain the following items.

The lab report should be written in standard format, containing

- Cover page
- Purpose of experiment
- Test configuration
- Circuit tested
- Test procedure
- Measured results
- Comparison of results
- Conclusions

The comparison section should compare the voltage gain and loaded current gains with theoretical values. It should also compare the measured input resistance with theoretical. Drawings of the four linear-amplifier models with labeled parameter values should appear in the report.