EC410 Lab #8 – Spring 2008

TRANSISTOR AMPLIFIER DESIGN (2-3 Week Experiment)

BACKGROUND
This experiment will be the last one in the course. You may work on this experiment until the close of laboratory time in EC410. This date will be determined by the course staff and communicated to you by the GTFs.

The objectives of this lab are simple: Pull together all the things you have learned in EC410, and design a transistor amplifier capable of meeting a desired set of specifications.

Note: The objectives of this lab may *not* be met by using operational amplifiers. Somebody has to design the circuitry inside the op-amp, and this lab will give you a flavor for that task, albeit at a very elemental level.

Shown below are some of the canonical amplifier forms that you should have studied in class. Any one of them, alone or in combination, can be useful in achieving the objectives of this lab:
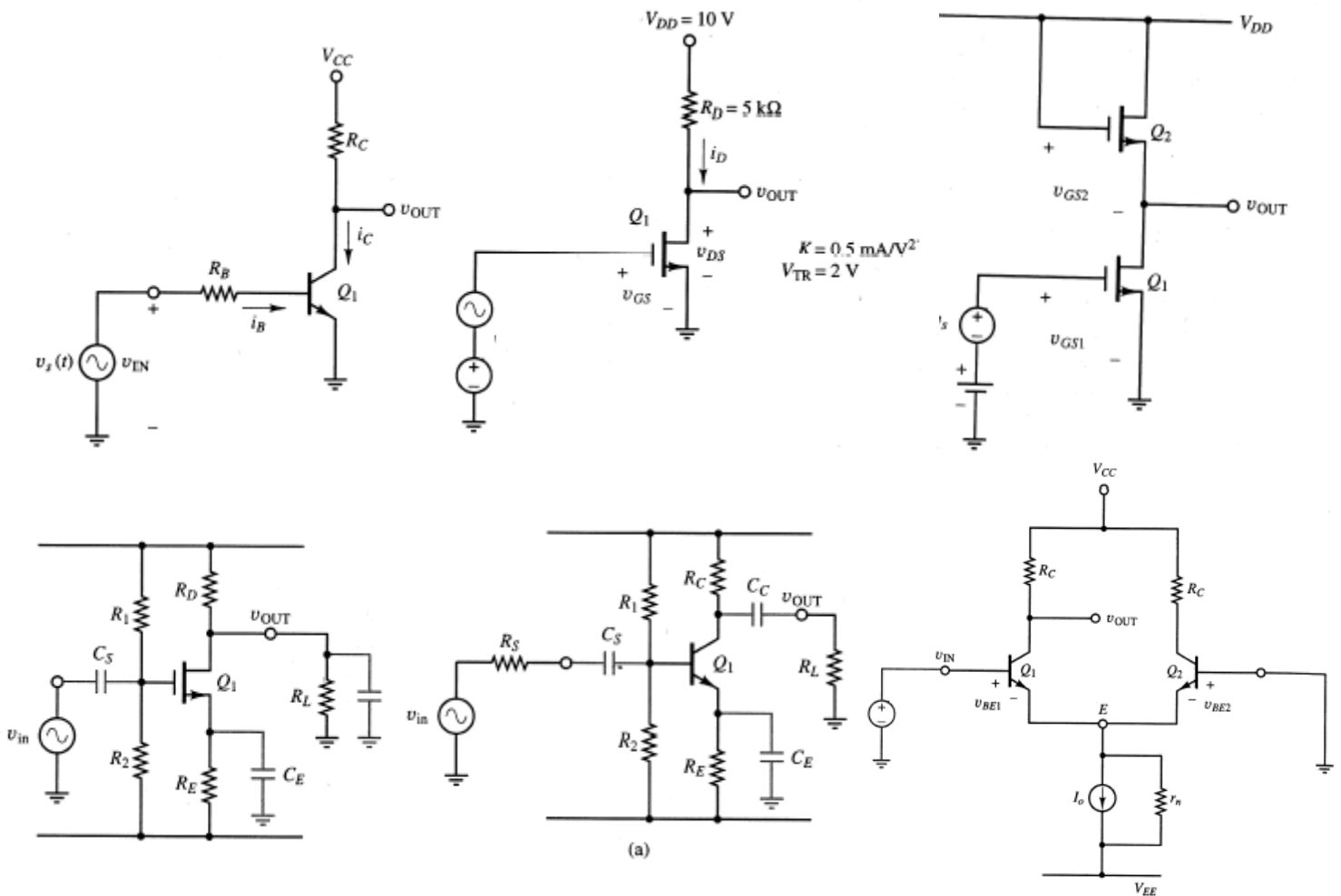
Laboratory Goal:	To design a transistor amplifier capable of meeting a set of specifications.
Learning Objectives:	Biasing, gain, and frequency response.
Suggested Tools:	Laboratory instruments, PSPICE, National Instruments Elvis system

ASSIGNMENT

Level 1: Design, build, and test a transistor amplifier capable of meeting the following specifications:

Table 1 – Amplifier Specifications		
Parameter	Value or Range	Comments
Gain	$10 < |A_v| < 20$	Gain can be positive or negative
Minimum Output Swing	8 V peak-to-peak	Output may not have any dc component
Low Frequency Cutoff	200 Hz	The specified frequency range corresponds to the telephone audio bandwidth. One typically limits the bandwidth so that a) noise outside the passband can be eliminated, and b) many channels can be duplexed together on limited frequency spectrum
High Frequency Cutoff	5000 Hz	
Input Resistance	$R_{in} \geq 10 \text{ k}\Omega$	
Output Resistance	$R_{out} \leq 100 \ \Omega$	

Level 2: Determine the Bode plot (log-log plot of gain versus frequency) using the Elvis automated measurement system. A guide to using this hardware/software system may be found below.

Level 3: Increase the gain of your amplifier so that it has a magnitude of 100.

Using the Elvis Bode Analyzer System

The National Instruments Elvis system is housed in the white box that has multiple superstrips attached to its top. This box is linked by a big cable to your PC. Basically, Elvis is a "one-stop-shop" device that allows you to build, test, and analyze circuits rapidly via automated data acquisition.

In this lab, the feature you are asked to use is the Bode Analyzer program contained within National Instruments Labview Signal Express. Your PC is loaded with *many* software programs from NI, so it's important that you open the right program. Otherwise, you may have difficulty getting the system to work.
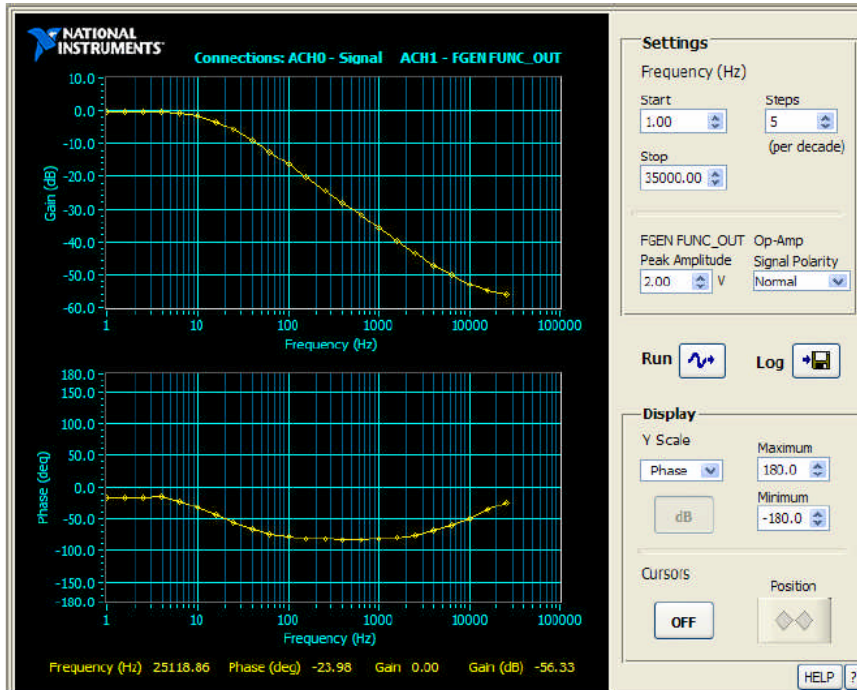
For this lab, you want: National Instruments Labview Signal Express
You do *not* want: ELVIS, Labview 8.x, Labview 7.x, or National Instruments DAQ.

Steps to Success:
1. Open Labview Signal Express
2. Click the +Add a Step icon at the top of the screen
3. Choose ELVIS → Analog → Bode Analyzer.

If you've done all this correctly, you'll see the following screen:


What the Elvis Bode Analyzer does:
- Creates a sine wave whose frequency is varied in discrete steps.
- Monitors the input and output signals to the circuit under test (your amplifier)
- Plots the gain magnitude and phase of the output (relative to the input) on log-log scales, with the vertical scale in decibels (dB).

Remember that dB = 20 $\log_{10}$ V$_{out}$/V$_{in}$

Comments:
The output of Elvis's function generator appears at the tie-point labeled FUNC-OUT.
The system expects the amplifier's input signal to be connected to the ACH1 terminals (analog channel 1), and its output signal to be connected to the ACH0 terminals.

Important Note: The analog inputs to the data acquisition system are *differential*; that is, they measure voltages between their (+) and (−) terminals irrespective of ground, just like an op-amp. If your amplifier input and output are referenced to ground, you'll need to connect everything as follows:
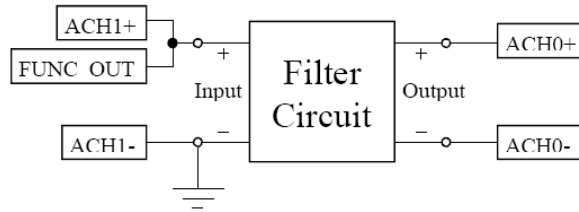
You can use the on-screen interface to change any of the following:

- Frequency sweep start and stop frequencies
- Number of discrete data points per decade in frequency
- Amplitude of the function generator signal applied to the amplifier

Last but not least: To start the Bode plot analysis, click RUN at the top of the screen. Have fun!
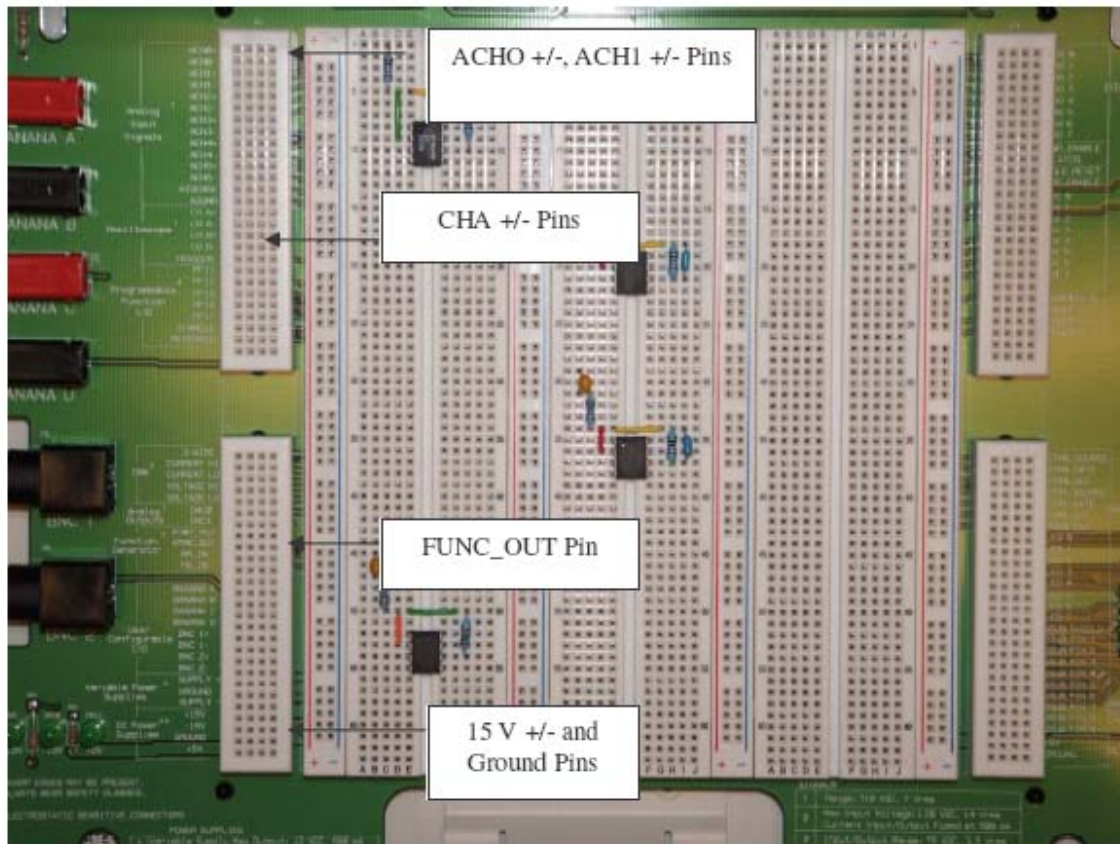
By the way, ELVIS stands for "Educational Laboratory Virtual Instrumentation Suite," not the King of Rock 'n' Roll: