

**6.002 Demo# 04 (load set up demo#04L.set)**  
**Nonlinear Device**  
**Lectures 6, 7**

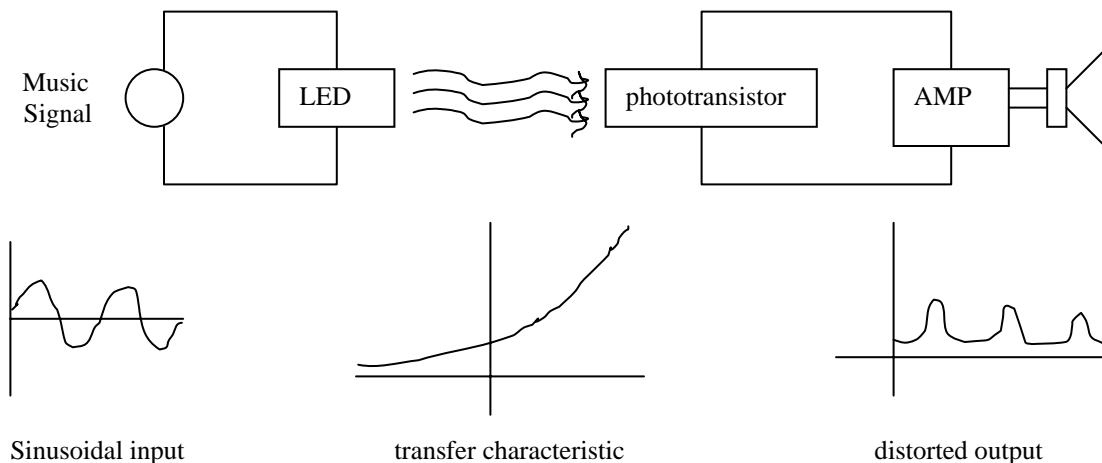
**Agarwal Fall 00**

Purpose:

In this demo, a nonlinear device (a photo-transistor) is examined to motivate the concepts of linearization and small-signal models. The nonlinear transfer characteristic for the system including the photo-transistor is shown on the scope. A music signal is then applied at the input, and the output is shown as a function of the input (as a segment of the transfer characteristic). The output is also sent to a speaker. The nonlinearities are then seen on the scope and heard as distortion, by adjusting the amplitude and bias of the input. It is an interesting aside to show (by blocking the light beam) that the music is in fact being sent as a modulation of the light intensity.

Steps:

1. Using a large sinusoid, show on the scope the transfer characteristic of the nonlinear device, along with the input sinusoid and distorted output waveform. The tone can also be played through the speaker, so the distortion can be heard. (Stop here in lecture 6 to show nonlinear analysis).
2. (Do this in lecture 7). Reduce the amplitude of the sinusoid to show that (via small-signal linear approximation) the output is an almost perfectly faithful (ignoring scaling) copy of the input.
3. Switch the input from the sinusoid to music (CD player) in which distortion is easily heard. Adjust the amplitude to show the effect of the nonlinearity.



**Description:** Nonlinear resistors, diodes, load line analysis, small signal.

**Linearization of Nonlinear Device (small-signal):** Music played through optical connection

**Note:** see schematic diagram next page for more detail; Fg1

**Oscilloscope Setup**

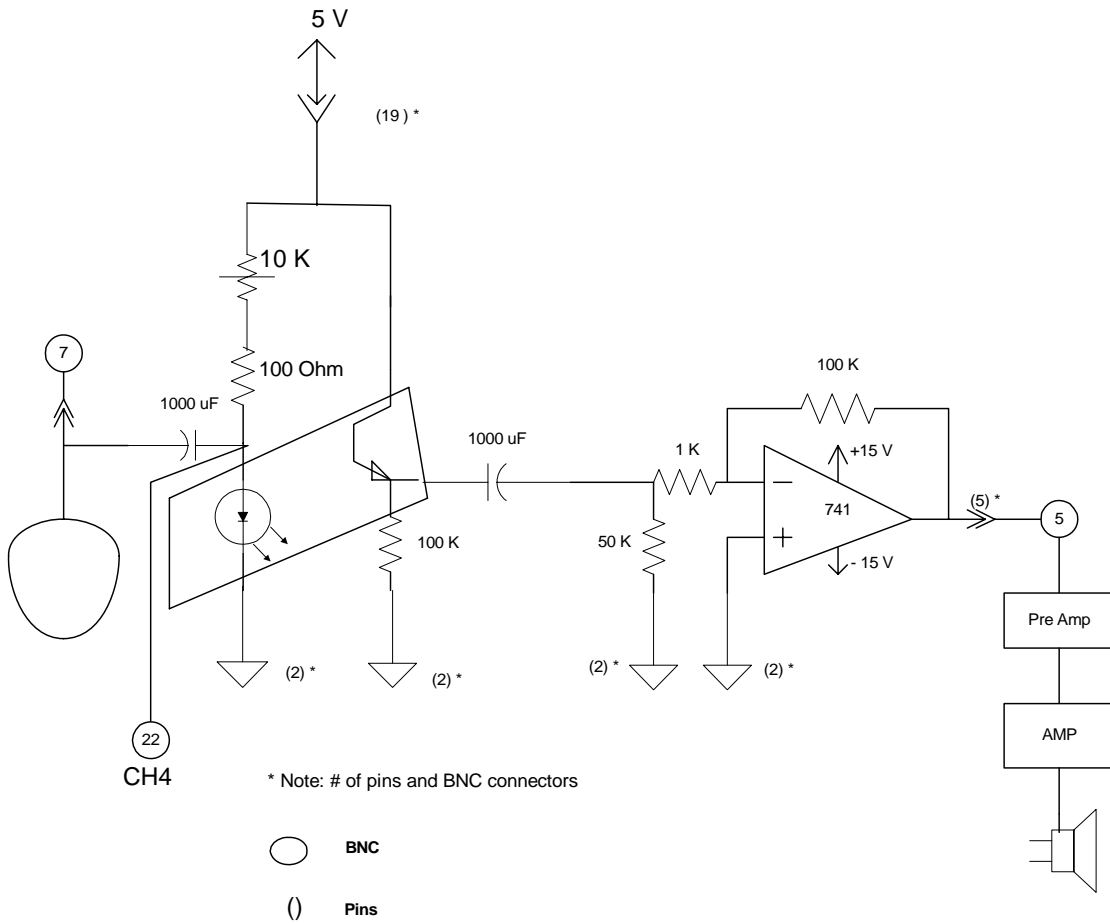
CH	V/DIV	OFFSET	MODE	FUNC	MATH	VERTICAL	HORIZONTAL
1	on	1	-1.07 V	DC	off		

2	on	200 mV	214.7 mV	DC	off
3	off				off
4	off				off
Horizontal:	5ms	Acquisition:	AUTO	AUTO	4
		Trigger:			CH1

Waveform Generator Setup					Power Supply Setup			
UNIT	WAVE	AMP	OFFSET	FREQ	+6	+25	-25	OUTPUT
					+5	+15	-15	
FG2	Sin	500 mV	0	500 Hz				Trigger: INT

**Note: Jeff starts with 6 v Supply set @ 2.7 V and amplitude of FG2 @ 500 mV. Later he changed the amplitude of FG2 to show distortion.**

### Non Linear Device



- 4A) Set FG2 = 500 HZ sine Amp = 1.5 v P-P @ 50 Ohm  
 4B) Set FG2 = 500 HZ sine Amp = 1 v P-P @ 50 Ohm

Prof. Agarwal Fall 00