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E3083 Electronics Circuits Lab
Experiment 5 Lab Report
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Phaser "Pedal"

Abstract
The purpose of this project is to create a phaser "pedal"—a common electronic sound processor used by musicians to vary tones over time, creating a sweeping effect. This is achieved through cascading unity gain buffers that, while maintaining the frequency of the signal, shift it out of phase—hence the name "phaser." To achieve this, the input signal must be summed with the shifted input signal, allowing for the reconstruction and change in tone that is desired.

Guitarists commonly use the phaser pedal in rock songs and examples of this processor can be heard in many songs by Queen, Van Halen, Jimi Hendrix, and more. Listening to an example of the phaser pedal in action can provide great insight into the desired effect. A good place to start is here.

Block Diagram

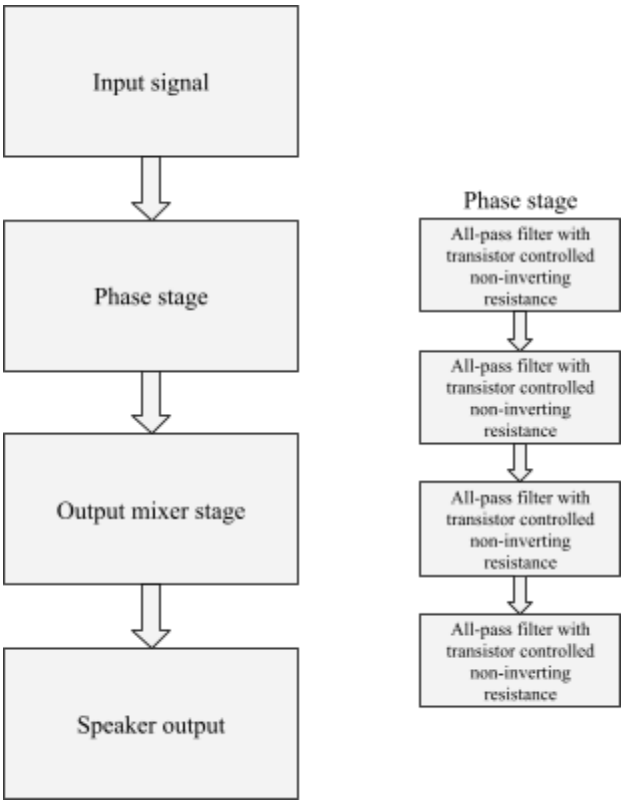

Figure 1: Phaser pedal block diagram showing each stage of the pedal.

Schematic

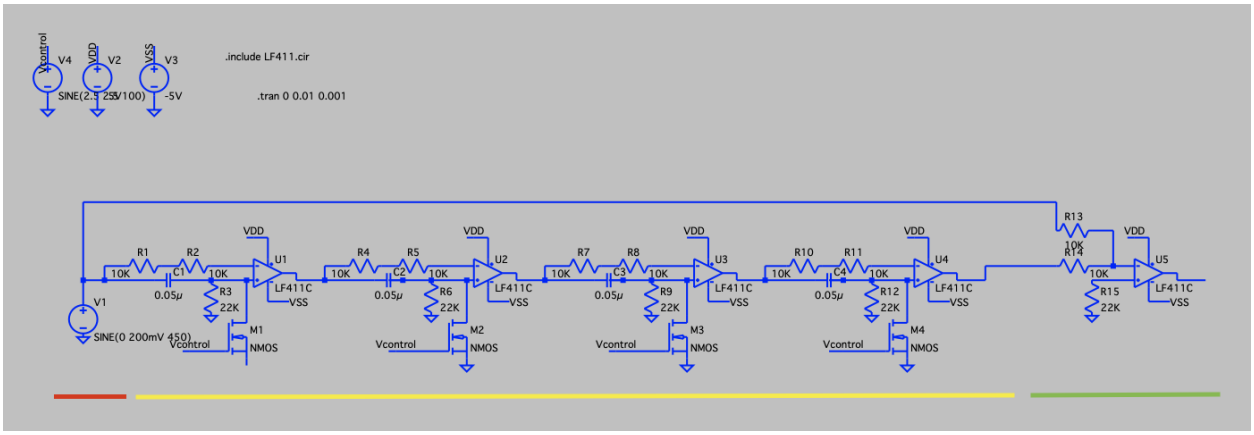

Figure 2: Schematic of the phaser.

Input stage(red)
In the input stage, a signal—often the music being played—is passed into both the phase stage and the output mixer stage.
Phase stage(yellow)
The phase stage consists of four individual but identical stages that are all-pass filters. When cascaded, these produce a phase shift of 180º. We attach an NMOS transistor to the non-inverting input of each stage to act as a variable resistor. When these transistors' gate voltages are varied we see them entering and leaving the linear resistance region. This means that each transistor acts as a variable resistor.
Output mixer stage(green)
Using a summing op-amp, the output mixer stage sums the input signal and the phased output signal to produce the final signal. This results in the distinct sounds of the phaser pedal.

The outputs of each stage can be seen below in *Figure 3* and *Figure 4*.

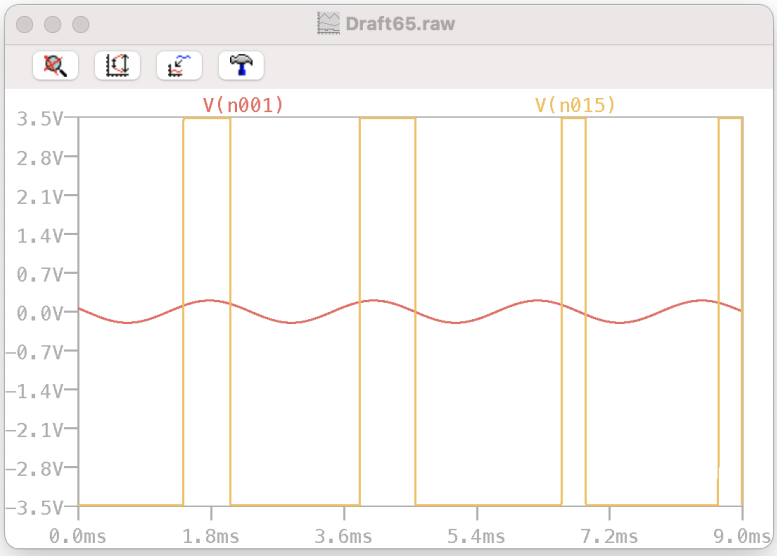

Figure 3: Input signal and final phased signal.

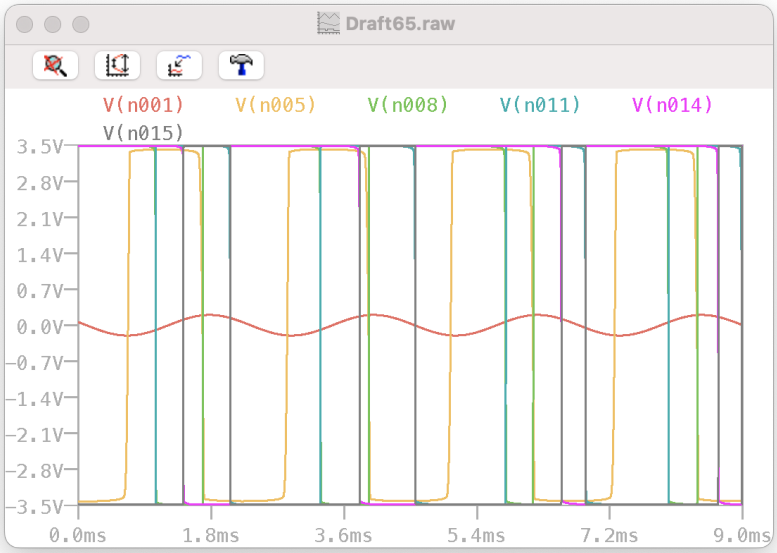

Figure 4: Input signal and each subsequent output signal.

Experimental Results

We can build the phaser pedal using this model. The completed circuit, seen in *Figure 5*, shows the physical construction of the pedal. This circuit does produce a phased output signal as expected, which can be viewed here. To better understand the physical implications of the phaser pedal, we tested a version of the pedal that utilizes individual 10kΩ potentiometers. This allows for us to see the effect that each stage has on the output. The following figures demonstrate the output of the signal. Note that, once connected to a speaker, the loaded circuit produces outputs that demonstrate a large connected impedance.

Additionally, due to physical limitations, we were only able to obtain a phase shift of 176.80º. With more time, we would like to experiment with limiting the capacitance due to the breadboard experienced by the pedal, as this decreased load may help to better achieve a 180º shift.

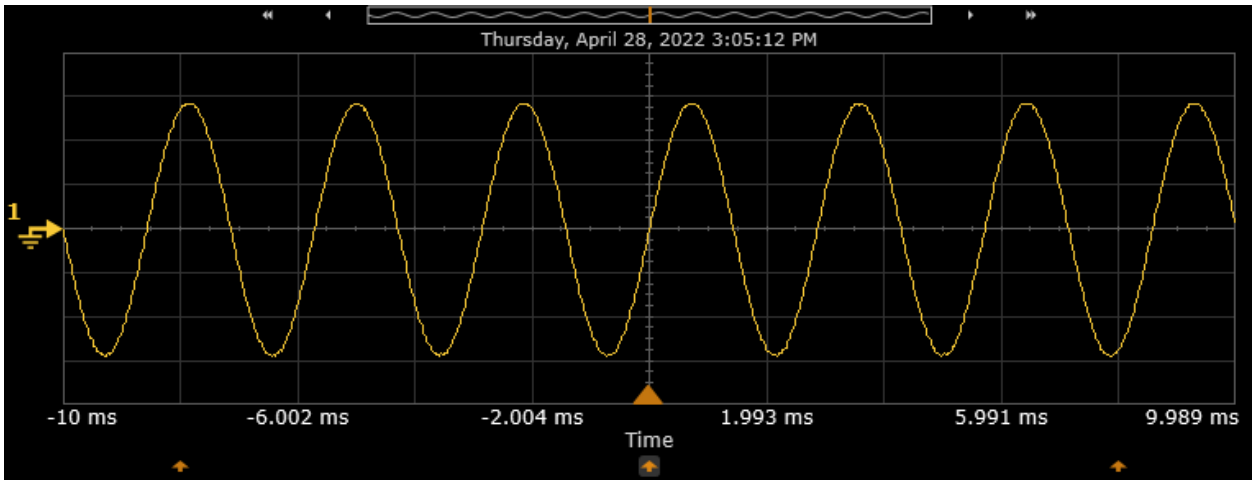

Figure 5: Input signal.

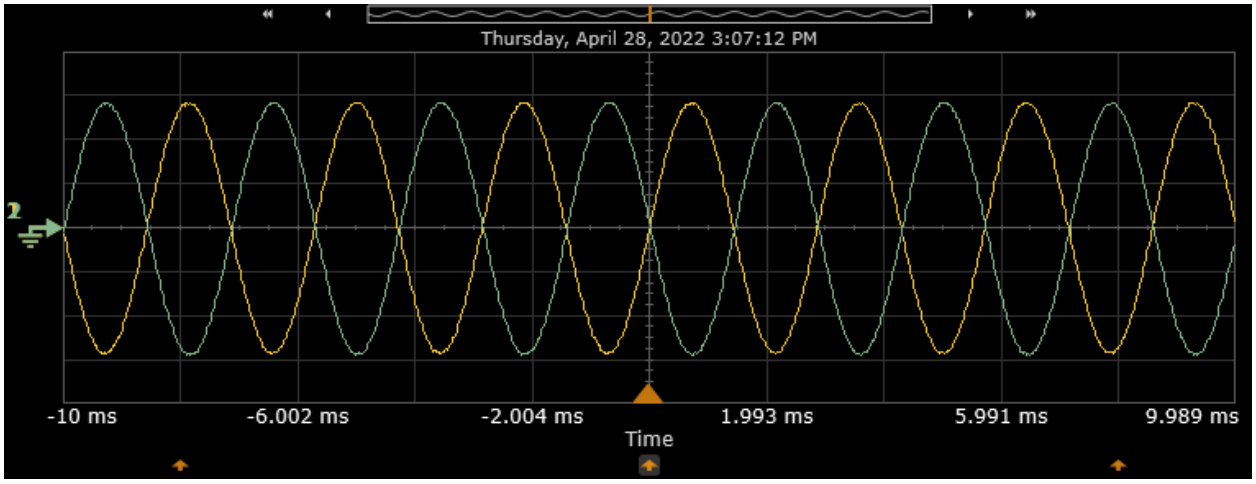

Figure 6: Output signal with a 176.80º phase shift.

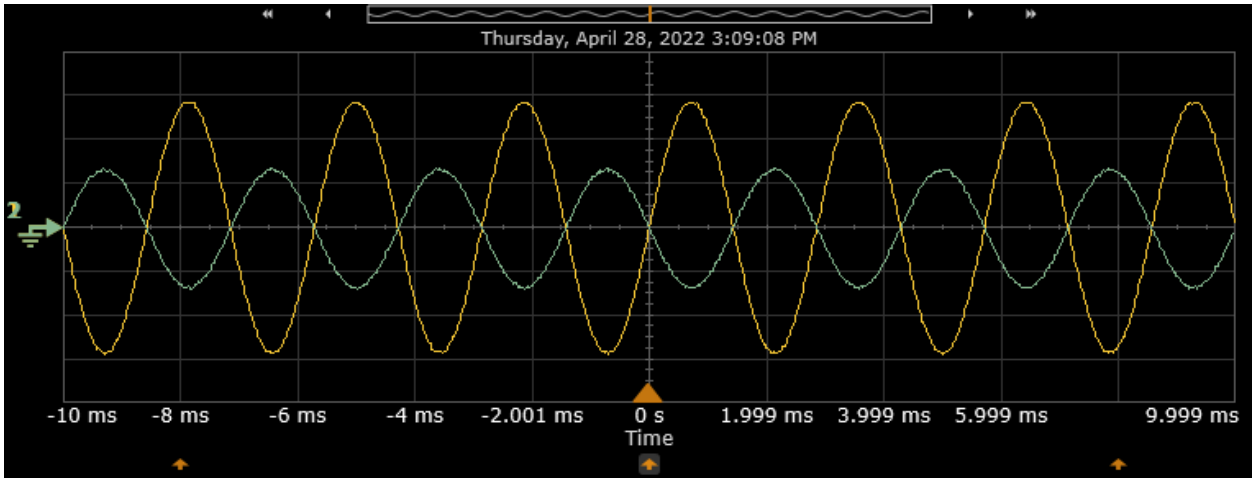

Figure 7: Output signal at second stage with variable resistances attached

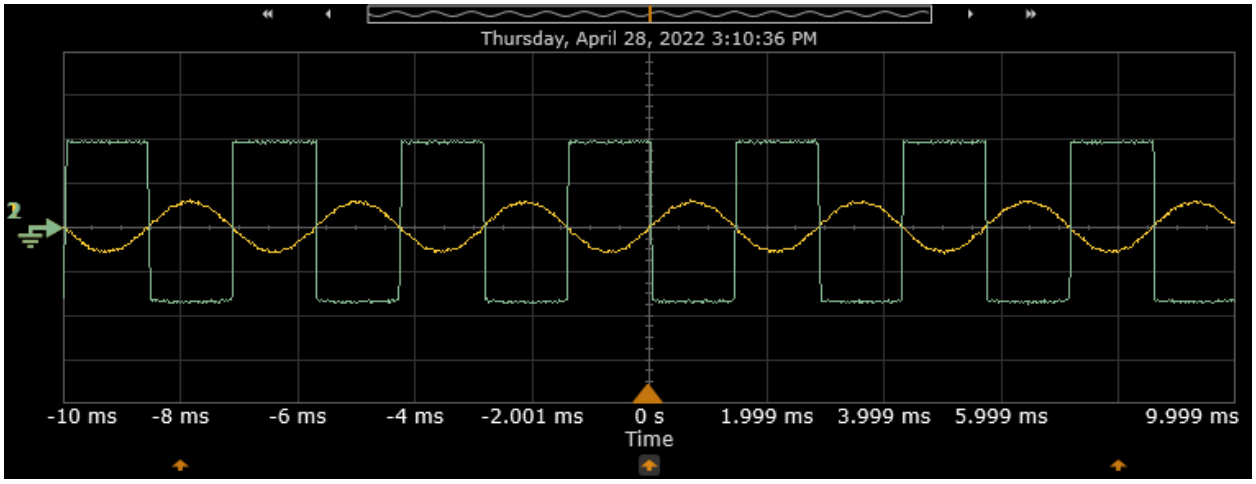

Figure 8: Output signal at summing stage with no load

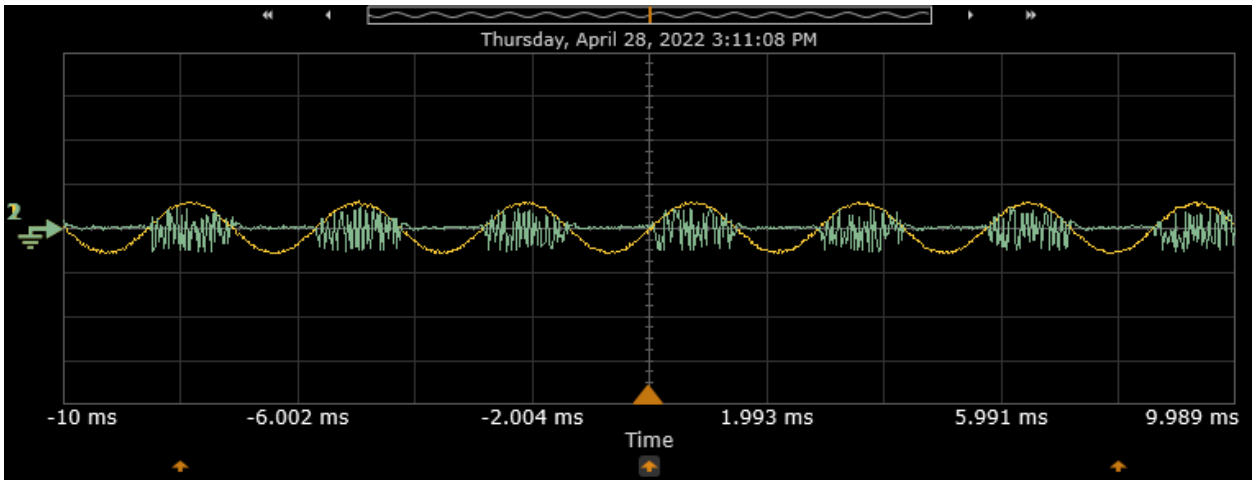

Figure 9: Output signal at summing stage with load

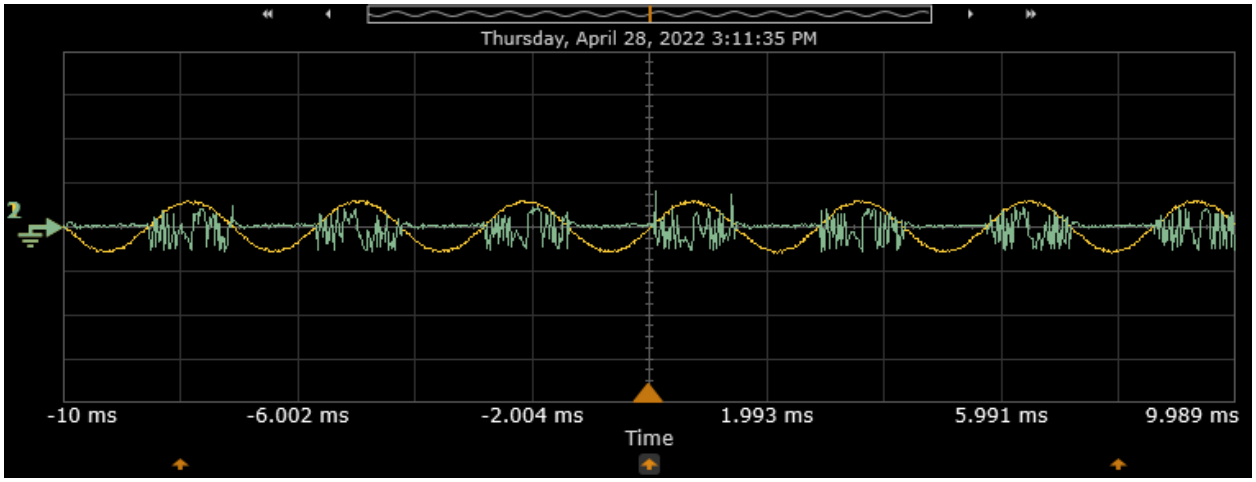

Figure 10: Output signal at summing stage with load