Electronics Course Project 1 2018-2
Duffing-Holmes Oscillator

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Introduction: Chaos is not disorder, it is just a system that varies a lot with a small change in its boundary conditions, in this case we will look at the Duffing-Holmes (D-H) chaotic oscillator, as we saw in class, with a few electrical components we can resemblance quite accurate various types of mathematical operations, even the second order non-linear ordinary differential D-H equation described below.
Main: This is a quite unique oscillator because it brings together a handful of concepts, we will start by mentioning hooke's law $F_s = -k \cdot s$, this law tell us about the force that a spring exerts F_s, according to k, which is the spring constant and s that correspond to the displacement of our spring, the whole concept spins around the storage of some energy that it later releases. Other powerful concept is the dampening, or the attenuation over time of the movement.
Let's look at it's equation $\ddot{x} + b\dot{x} - x + x^3 = a\sin(\omega t)$, where $x(t)$ is the position over time, a is the amplitude , b is the damping coefficient and ω is the frequency of the external driving force. We will adjust these constants in order to obtain some interesting Lissajous figures showed in Figure 2 and 3.
Circuit: The circuit used was taken from [1], we have just added a voltage measuring point proportional to the current flowing trough R1, the most interesting feature lies in the fact that although all its elements are linear,as a whole it behaves non-linearly due to the feedback loop consisting of the resistor R2 and both diodes

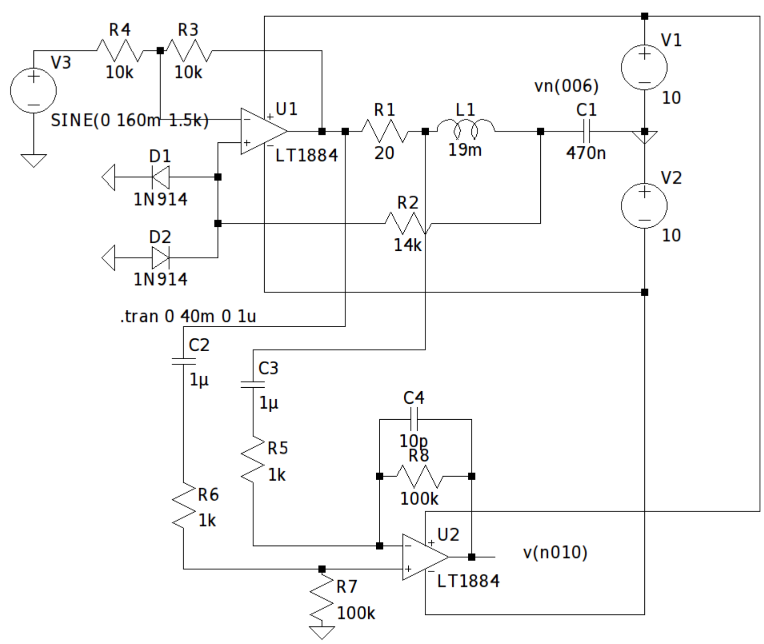

Figure 1: Schematic of the used circuit

Simulation: The lt spice simulation shows the behaviour of the non linear system, in this case we show the Lissajous curve in this case is voltage over voltage for the nodes v(n010) and v(n006) listed in the circuit, this curve it is modelled for a time of 40 milliseconds, ans shows some kind of hysteresis.

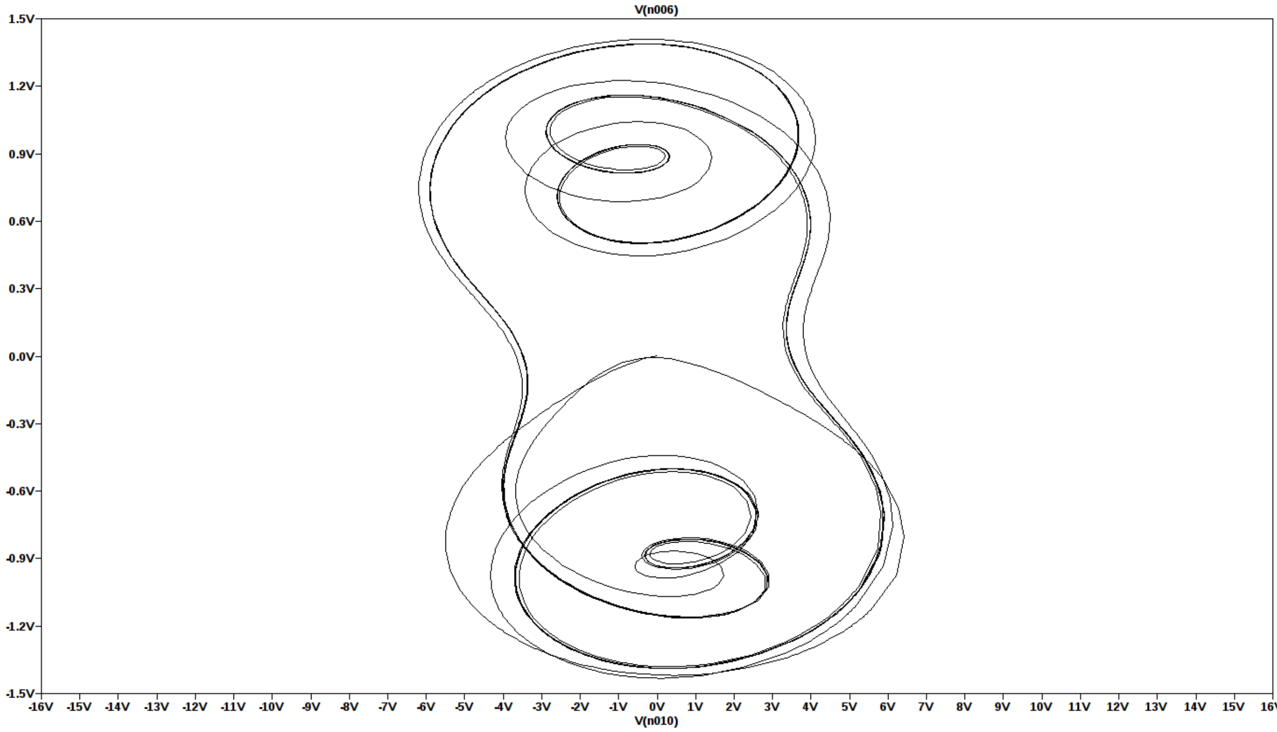

Figure 2: Simulation output for the desired lissajous curve

Results: Once we landed the circuit in hardware, we found that the real approach is not quite the response we had expected due to poor selection of components that gave us some nasty noise, we are not sure of the properties of these elements at the frequencies used in our simulation. Nevertheless the output (Figure 3) seems to be quite loyal to the desired result.

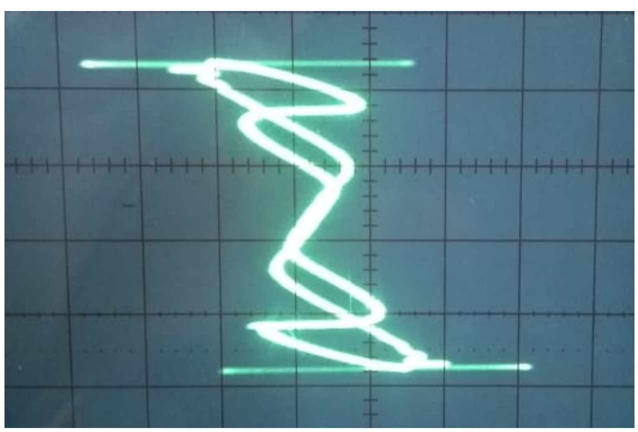

Figure 3: obtained lissajous curve fom the ossciloscope, using the xy function

Bibliography: [1]Analogue Electrical Circuit for Simulation of the Duffing-Holmes Equation,Tamaseviciute, E.; Tamasevicius, A.; Mykolaitis, G.; Bumeliene, S.; Lindberg, Erik,2008