Paris S. Miles-Brenden - Mar. 5th, 2012
Project Proposal - ECE 595 - *Amplifier with Reverb, Attenuation, and Echo Effects*

Apologia: I had originally intended to build a touch interface capable of reconstructing the field configuration of a convex region by way of the boundary by using an inverse Green's functions method. Given this project is involved and does not offer a way to scale the project down to what would be conducive to building in this short timespan, I would like to build something different.

The proposal for this project is to build an (audio) amplifier capable of: Attenuation and Reverb to Echo effects via tunable knobs (potentiometers). The audio amplifier should pay special attention to input and output impedance, voltage, and power rescrictions (so as not to damage any equipment it is hooked up to, i.e. the input and output equipment). This relies on several concepts of the course so far such as impedance matching and overvoltage protection, possibly by way of diodes and capacitors.

As well, I would like to build the amplifier from scratch based around a concept of altering the response curve height and width, and resonant frequency of a parallel RLC circuit based around Vacuum Tubes and an IC to replicate the signal for reverb and echo effect. I believe this will offer a hands on approach to learning about signal modification, vacuum tubes, and will use a nonlinear or digital component. For now, an IC can be used which will produce an echo and other effects (like the TDA1022 or FV-1 from Spin Semiconductor), although I would prefer if it is possible to produce an all-analog design that features reverb as an effect. Ultimately non-vacuum tube op-amps could be used.

In the RLC circuit, coming from the differential equation, with forcing current $i_f(t)$:

$$L\frac{d^2i(t)}{dt^2} + R\frac{di(t)}{dt} + \frac{1}{C}i(t) = i_f(t) \tag{1}$$

There exists a transient response and steady state response from the signal. As well, a typical resonator has a Lorentzian response:

$$I(\omega) = \frac{(\frac{\Gamma}{2})^2}{(\omega - \Omega)^2 + (\frac{\Gamma}{2})^2} \tag{2}$$

Given this Lorentzian is a function of attenuation constant and fundamental frequency;

$$\Gamma = \frac{R}{2\sqrt{\frac{L}{C}}} \qquad \Omega = \frac{1}{\sqrt{LC}} \tag{3}$$

It should be possible with separate stages of amplification; one for resistance, one for inductance, and one for capacitance, coupled in parallel with each admitting potentiometer adjustment (P) of their gain and hence their contribution as parts of one parallel RLC circuit to produce variable properties in (Γ, Ω). This produces the following RLC circuit equation:

$$L(P_1)\frac{d^2i(t)}{dt^2} + R(P_2)\frac{di(t)}{dt} + \frac{1}{C(P_3)}i(t) = i_f(t) \tag{4}$$

The idea of this is to gain separate control over attenuation and reverb as functions of resonant frequency, with a Lorentzian as the prototypical response curve. Since the RLC acts as a way to produce a sinusoidally varying envelope for the frequencies coming from the signal input, all that it needs do is produce a response to a series of input frequency components, to produce reverb and attenuation. A preliminary sketch of the RLC portion of the circuit is on the back.