ENGR142 Engineering Physics
Assignment Nine

Due 19th of October 2018

1. [10 marks] An audio signal needs to be split into two components; a low frequency component ($f < 2$ kHz) that will be sent to a low frequency speaker (a woofer), and a high frequency component ($f > 2$ kHz) that will be sent to a high frequency speaker (a tweeter). Design an RL low pass filter *and* an RC high pass filter that will achieve this.

   Your design should use a capacitor value somewhere in the range between 0.1 nF and 100 nF and an inductor value somewhere in the range 1 μH and 100 μH. (These are readily available values that work well for audio signals.)

2. [10 marks]

   The lecture notes make the claim that if we build a second order low pass RLC filter with $R = \sqrt{\frac{2L}{C}}$, then the gain at the cutoff frequency ($\omega_c = \frac{1}{\sqrt{LC}}$) is the same as for the first order filter. Show that this is the case.

3. You wish to build a second order high pass filter using a series RLC circuit. Recall that the output voltage is taken across the terminals of the inductor in this circuit.

   (a) [5 marks] You have a 1 mH avaiable and want your filter to have a cutoff frequency of 100 kHz and a Q of 20. Choose appropriate values for the capacitor and resitor to achieve the specifications.

   (b) [5 marks] You discover that the inductor actually has an equivalent series resistance of 3 Ω due to the non-perfect wire used to make it. That is, the real inductor looks like a 1 mH inductor in series with a 3 Ω resistor. What is the Q of the real circuit?

   (c) [5 marks]Extension: Find a transfer function for the filter incorporating the presence of the inductors resistance. For simplicity you don't need to use real values, just call the inductors resistance R_L.