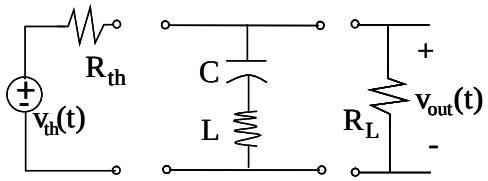
ECE 3364, Dr. Hebert, Fall 2016, Homework 12 due 11/29

Problem 1. For the band-reject filter



a) derive the transfer function $H(j\omega)$ and magnitude $|H(j\omega)|$ in units of rad/sec for ω.

b) Find $|H(j0)|$

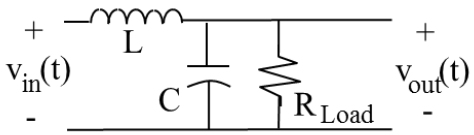
c) Find $\lim_{\omega \to +\infty} |H(j\omega)|$

d) Find $\max_{\omega} |H(j\omega)|$

e) Find $\min_{\omega} |H(j\omega)|$

f) Find the lower and upper -3 dB frequencies.

Problem 2.



(a) Compute the transfer function $H(s)$

(b) Compute the magnitude of the freq response $|H(j\omega)|$

(c) Compute $|H(j0)|$ as a function of R, L, C

(d) Compute $\lim_{\omega \to +\infty} |H(j\omega)|$

(e) Find the frequency ω_m at which the magnitude of the transfer function $|H(\omega)|$ is maximum.
You might do this by finding the minimum of the denominator with respect to ω; take the derivative of the denominator with respect to ω and set it equal to zero, then solve for ω.

(f) Compute the -3 dB frequency ω_{-3dB} as a function of R, L, C.

(g) Is this a Butterworth filter? You should be able to answer "yes or no" on the basis of your result in (e).

In general, the approach would be to form $|H(j\omega)|^2$ and see if you can factor it into the form $|H(j\omega)|^2 = \frac{c_0}{1+(\omega/\omega_{-3dB})^{2N}}$

(h) Where the load impedance is $R_L = 8\,\Omega$, design the filter to have a cut-off frequency of 10K Hz.

Problem 3.

Given a load resistance $R_L = 8\,\Omega$, design a 3rd-order Butterworth filter with a cut-off frequency of 3000 Hz.

Problem 4.

Download the software TransferFunction.exe under "HW12" on the course web page and generate the plot of the magnitude of the transfer function of your (speakers+ears) versus the log of the frequency from 200 Hz to 28K Hz.