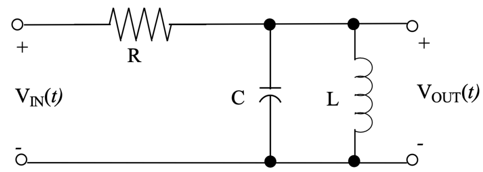
Prelab 6 – What to Expect from the RLC Circuit

> **Note:** While you will work as a team on the in-lab portion of this exercise, you should each do your own prelab. Answers to the questions below should be entered online at the link provided on the ELE 215 website.

Lab 6 considers the RLC circuit:

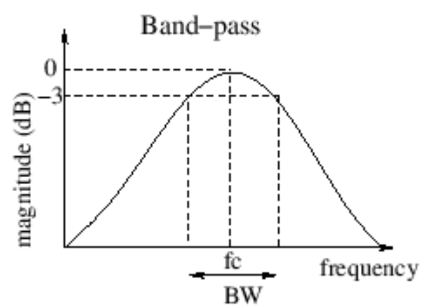


This circuit can be analyzed as a voltage divider. Letting Z_1 represent the impedances (in terms of frequency, f) for the top portion (the resistor alone) and Z_2 be the right-hand portion (the inductor and capacitor in parallel), then the transfer function for the output across Z_2 is

$$H(f) = \frac{V_{OUT}}{V_{IN}} = \frac{Z_2}{Z_1 + Z_2}$$

The magnitude portion of the Bode plot ($20\ \log_{10}|H(f)|$) for this circuit looks like this (as described in Recitation 7):

- It has a peak magnitude response equal to 1 (0 dB) at the "center" frequency f_c.
- The magnitude response falls away towards zero ($-\infty$ dB) on both sides of this center.
- It is common to describe the bandwidth BW as the span of frequency between the two -3 dB response points.



For this prelab you are to theoretically compute the parameters of your particular circuit's; you will be verifying those parameters on the real circuit during Lab 6.

Procedure:

1. Follow the link on the ELE 215 website to find the nominal R, L, and C values for your particular circuit; note that these will be identical to those for your posted lab partner.

2. Use MatLab with these values to generate the theoretical Bode plot for the circuit above:

- Experiment with the choice of frequency range to see the circuit's entire bandpass characteristic; you want to see the magnitude response range from about -30 dB for low frequencies, going up to 0 dB, and then falling back down to about -30 dB for higher frequencies; use lots of frequency points to get a smooth curve.
- Use MatLab's zoom tool to estimate f_c; you can also find f_c analytically by maximizing the magnitude of the transfer function.
- Whichever approach you use, enter f_c into the online grading tool. Instead of significant figures, please round the frequency to the nearest multiple of 10 Hz.

3. Two other frequencies of interest for bandpass filters are the 3 dB frequencies (sometimes called the -3 dB frequencies), at which the magnitude term is equal to 0.707 of the maximum value. Find these two frequencies, one above and one below f_c and enter them via the online tool (again, do this to an accuracy of 10 Hz). I can suggest two methods for finding these: graphically, by zooming into the Bode plot in MatLab or analytically by setting the magnitude of the transfer function equal to 0.707 of the peak value and solving for the frequencies.

4. Two more frequencies of interest for this problem are when the magnitude term is equal to 0.1 of the maximum value; this is equivalent to a -20 dB response below the peak. Find these two frequencies, again one above and one below f_c and enter via the online tool (again, to an accuracy of 10 Hz, please). As above a graphical or analytical approach is fine.

5. Finally, generate the Bode plot for your circuit; use at least 100 points (and use MatLab's logspace command for the actual frequencies) on a frequency range that spans the two -20 dB frequencies. Plot the data in standard Bode plot form.
   - While you do not need to upload this plot, one of your pair needs to print it to show to the TA at the beginning of the lab session before you start working.
   - Save your scripts for reuse after data collection.