Experiment 9 Solutions: Driven RLC Circuits

Part 1: Driving the RLC Circuit on Resonance

Now we will use the function generator to drive the circuit with a sinusoidal voltage.

1. Enter the frequency that you measured in part 1 of the lab as a starting point to find the resonant frequency.

2. Press GO to start recording the function generator current and voltage vs. time, as well as a “phase plot” of voltage vs. current.

3. Adjust the frequency up and down to find the resonant frequency and observe what happens when driving above and below resonance.

Question 1:

What is the resonant frequency? What are two ways in which you know?

The resonant frequency is 585 Hz. We can tell both by seeing that the current is a maximum at this frequency (which you can see by moving up and down in drive frequency) and by seeing that the current and drive voltage are in phase (which you can see in both the time based plot at left and in the phase plot at right).
Question 2:
What is the impedance of the circuit when driven on resonance (hint: use the phase plot)?
The impedance is \( Z = \frac{V_0}{I_0} = \text{slope of phase plot} = \text{resistance} = 9.1 \, \Omega \)

Question 3:
When driving on resonance, insert the core into the inductor. Are you now driving at, above or below the new resonant frequency of the circuit? How can you tell? Why?
Since the voltage leads the current we are inductor like, which means we are above resonance. When we inserted the core we increased \( L \) and decreased \( \omega_0 \), so we are now above it.

Part 2: What’s The Frequency?
For the remainder of the lab you will make some measurements where you are given incomplete information (for example, you won’t be shown the frequency or won’t be told what is being plotted). From the results you must determine the missing information. If you find this difficult, play with the circuit using the “further questions” tab to get a better feeling for how the circuit behaves.

1. Remove the core from the inductor
2. Press GO to record the function generator current and voltage

Question 4:
At this frequency is the circuit capacitor- or inductor-like? Are we above or below resonance?
The voltage is leading the current, so we are inductor-like and hence above resonance.
Part 3: What’s That Trace?

1. Press GO to record the function generator current and voltage as well as the voltage across the capacitor. Note that you are not told which trace corresponds to which value.

Question 5:

What value is recorded in each of the three traces (I, $V_{FG}$ or $V_C$)? How do you know?

Trace 1 (blue) leads trace 2 (red) by exactly 90º, so they must be the current and voltage across the capacitor respectively. The green curve (trace 3) does not have a nice phase relationship with the other two curves (it is slightly lagging the current, trace 1) so it must be the function generator voltage.

Question 6:

Are we above, below or on resonance? How do you know?

Since the function generator voltage is lagging the current we are capacitor-like, meaning that we are below resonance.