Laboratory Application Assignment

In this lab application assignment you will examine the resonant effect in both series and parallel *LC* circuits. You will construct a series *LC* circuit and see how the current, *I*, rises to its maximum value at resonance. You will also construct a parallel *LC* circuit and see how the impedance, *Z*, rises to its maximum value at resonance.

Equipment: Obtain the following items from your instructor.

- Function generator
- Oscilloscope
- 4.7-mH inductor
- 0.001-μF capacitor
- 47-Ω and 100 kΩ carbon-film resistors

Determining the Resonant Frequency, f_r, of a Series *LC* Circuit

Examine the series *LC* circuit in Fig. 25–22*a*. Calculate and record the resonant frequency, f_r. f_r = _____

Construct the series *LC* circuit in Fig. 25–22*a*. Connect channel 1 of the oscilloscope to the input voltage, V_{in}, and channel 2 across the resistor, *R*, as shown. Set the input voltage to 1 $V_{P\text{-}P}$ and the frequency, *f*, to the value calculated for f_r. While viewing the resistor voltage, V_R, move the frequency dial back and forth. Measure and record the frequency that produces the maximum resistor voltage, V_R. This frequency is the resonant frequency, f_r. f_r = _____

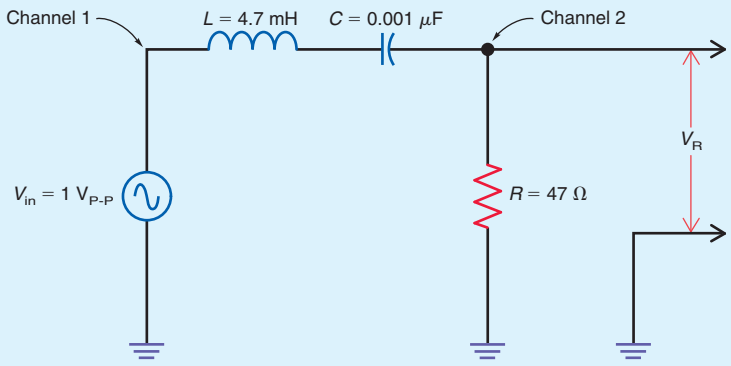
Record the measured value of V_R at f_r. (Make sure that V_{in} is still set to 1 $V_{P\text{-}P}$.) V_R = _____ Does the fact that V_R is maximum at f_r prove that the series current, *I*, is also maximum at f_r? _____ If your answer was yes, then explain why. ____

_____

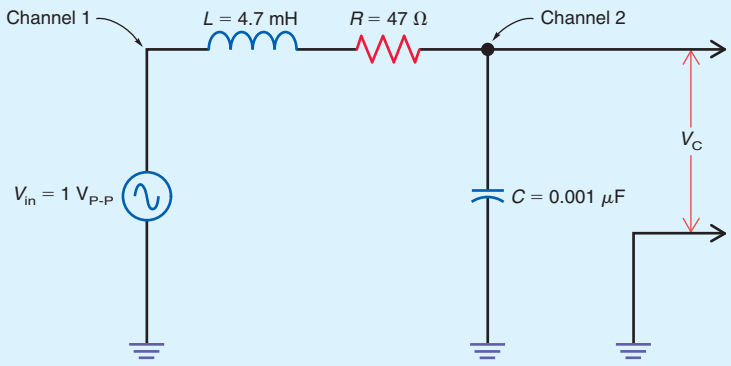
Using the measured value of V_R, calculate and record the series current, *I*, at f_r [$I = V_{R(P\text{-}P)}/R$]. *I* = _____ $_{P\text{-}P}$ Based on the fact that the current, *I*, decreases to 70.7% of its maximum value at the edge frequencies f_1 and f_2, experimentally determine the bandwidth, Δf, of the resonant circuit. (This may be difficult to do.) Δf = _____ Calculate the *Q* of the circuit using the measured values of f_r and Δf. *Q* = _____

Using the oscilloscope, measure and record the phase relationship between V_{in} and V_R at f_r. θ = _____

Figure 25–22



(*a*)



(*b*)

Does the series current have the same phase as the resistor voltage, V_R? _____ If so, what is the phase relationship between V_{in} and I at f_r? θ = _____

While adjusting the frequency dial above and below resonance, does the input voltage, V_{in}, dip at the resonant frequency? _____ If your answer was yes, explain why this occurs.

_____

_____

Rearrange the components as in Fig. 25–22*b*. Move the frequency dial back and forth until the capacitor voltage, V_C, is at its maximum value. The frequency at which V_C is maximum is the resonant frequency, f_r. This frequency should be very close to the frequency where V_R was maximum in Fig. 25–22*a*. Record the peak-to-peak capacitor voltage, V_C. V_C = _____ $_{P\text{-}P}$ Is this value larger than the input voltage, V_{in}? _____ If so, how is this possible? _____

_____

Determining the Resonant Frequency, f_r, of a Parallel Resonant Circuit

Examine the parallel *LC* circuit in Fig. 25–23. Calculate and record the resonant frequency, f_r. f_r = _____

Construct the parallel *LC* circuit in Fig. 25–23. Connect channel 1 of the oscilloscope to the input voltage, V_{in}, and channel 2 across the tank circuit. Set the input voltage to 10 $V_{P\text{-}P}$ and the frequency, f, to the value calculated for f_r. While viewing the tank voltage, V_{tank}, move the frequency dial back and forth. Measure and record the frequency that produces the maximum tank voltage, V_{tank}. This frequency is the resonant frequency, f_r. f_r = _____
Is the resonant frequency, f_r, the same as it was in Fig. 25–22? _____

Does this prove that the resonant frequency is calculated the same way for both series and parallel *LC* circuits? _____

_____

In Fig. 25–23, why is the tank voltage, V_{tank}, maximum at f_r? _____

_____

From the measured values in Fig. 25–23, explain how the tank impedance, Z_{tank}, can be experimentally determined. _____

_____

_____

What is the value of the tank impedance in Fig. 25–23? Z_{tank} = _____

What is the measured phase relationship between V_{in} and V_{tank} at f_r? _____

Does the input voltage, V_{in}, dip at the resonant frequency like it did in the series *LC* circuit of Fig. 25–22? _____ If not, explain why. _____

_____

Figure 25–23