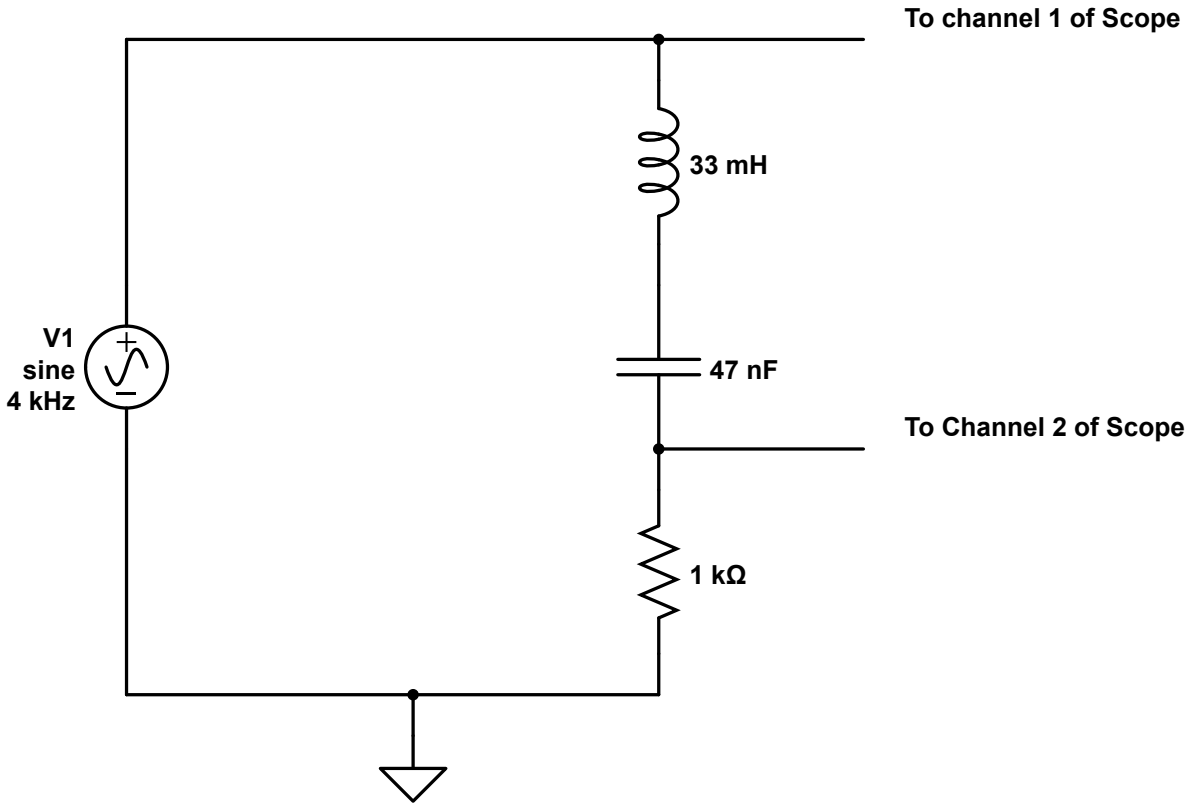
Lab 7

Sinusoidal Steady State Circuit

Set up this circuit on a breadboard, using the AFG3021C Function Generator as the voltage source and connecting Channel 1 and Channel 2 of the oscilloscope to the nodes indicated. Connect at least one of the "Scope ground clips to the ground node of the circuit.



Calculate the predicted resonance frequency of the circuit: $\omega_0 = \frac{1}{\sqrt{LC}}$, $f_0 = \frac{\omega_0}{2\pi}$

Recall that from class we have: $Z_{eq} = R + j\left(\frac{\omega^2 LC - 1}{\omega C}\right)$ we can rewrite this as $Z_{eq} = R + j\left(\frac{\frac{\omega^2}{\omega_0^2} - 1}{\omega C}\right)$, so

when $\omega < \omega_0$ the reactance is negative (capacitive) and when $\omega > \omega_0$ the reactance is positive (inductive). You might have heard or seen the mnemonic "ELI the ICE man", which tells us that

"Voltage (E) comes before (Leads) Current (I) in an Inductive (L) circuit, and Current (I) comes before (Leads) Voltage (E) in a Capacitive (C) circuit.

Turn on the 'Scope and set it to the following:
Horizontal Scale: 2 μs/div
Channel 1 Scale: 500 mV/div
Channel 2 Scale: 500 mV/div
Trigger on Channel 1, slightly above zero.

Set the Generator:
Run Mode: Sweep
Start Frequency: 1 kHz
Stop Frequency: 10 kHz
Amplitude: 1 Vpp
Sweep: 10 seconds
Channel On

You should see two sine waves displayed, with increasing frequency. The yellow trace (Channel 1) is the reference, the voltage across the whole circuit. The blue trace shows the voltage across the resistor, which is proportional to the current through the circuit.

The signal generator sweeps through frequency from 1 kHz to 10 kHz.

Watch as the signal goes from low frequency to high, and you can see that the current begins "leading" the voltage (ICE), then we go through resonance (voltage and current in phase), then as it goes to high frequency the current begins to lag the voltage (ELI).

Change the Run Mode of the Signal Generator to "Continuous" and set the frequency to 3 kHz. Is this above or below the expected resonance frequency? Move the cursor on the frequency display to the right one digit and slowly increase the frequency until the current and voltage are in phase and the current is a maximum. Best practice is to go beyond the point to see how it behaves, then move back to the proper value. Move the cursor to the right one more digit and balance it out again.

What do you measure the resonance frequency to be? _____

Try changing the capacitor to a 1 μF value and find the resonant frequency.

Demonstrate these to a TA, showing them that you can set up the swept frequency input and display, go to continuous mode and change frequency to find the resonance frequency.

Demo of Oscilloscope Skills LAB 7

1. The TA will ask each partner to set the signal generator to sweep frequency and discuss the display as it appears.

Partners:

_____

_____

Able to set generator?

_____

Able to explain the traces?