**Datasheet for Lab 13: AC Circuit Measurements**

Name(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Approximate time to complete:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Prelab: Watch the [Lab Overview Video](https://www.youtube.com/edit?o=U&video_id=zDDNc1QQYrw) and [In-Lab Questions](https://youtu.be/zDDNc1QQYrw?t=2186)

**PART 1 : Series RC circuit**



1. Measure and record the resistance of your single 470 Ohm resistor, the 0.1 uF capacitor (if you have a capacitance meter—online students assume 0.1 uF), and the internal resistance of the 33 mH inductor :

Resistance of 470 Ω Resistor \_\_\_\_\_\_\_\_\_\_ (measure with Ohmmeter)
Capacitance of 0.1 uF Cap \_\_0.1 uF\_\_\_ (assume ideal)
Inductance of 33 mH inductor \_\_33 mH \_\_ (assume ideal)

Table I. Theoretical Impedance calculations for a series RC network at 3 different
 values of ω. Recall that ω = 2πf. Show Zeq in rectangular and polar form.

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency, f | Frequency, ω |  |  |
| 1000 Hz |  |  |  |
| 4500 Hz |  |  |  |
| 10000 Hz |  |  |  |

Table II. Comparing Peak-to-Peak and RMS Values from the Oscilloscope and your
 DMM. Remember that Vpp is twice the value of Vm, and that . In
 row two, calculate the RMS value from the measurements in row one. You
 should get good agreement between the numbers in row two from your
 scope, and the numbers in row three from your DMM. The last column is
 constructed by dividing by your meaured resistor value from step 1 above.

|  |  |  |  |
| --- | --- | --- | --- |
| **Value Determination** | **Vs** | **VR** | **I (= VR /R)** |
| Scope Peak-to-Peak |  |  | replace with VR / R here |
| Scope pk-pk values converted to RMS Value |  |  | replace with VR / R here |
| DMM RMS Value |  |  | replace with VR / R here |

Table III Current phase measurement () at 1000 Hz. The phase angle should be
 close to 72 degrees.

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency, f | T, ms  | Δt, ms | , degrees |
| 1000 Hz |  |  |  |

1. Enter the phasor representation of ***VS*** and ***I***. Use the peak-to-peak values for the amplitude. The phase angle of ***VS*** is zero and the phase angle of ***I*** is determined in Table III.

Phasor ***VS*** = \_\_\_\_\_\_\_\_\_\_\_ < 0o

Phasor ***I*** = \_\_\_\_\_\_\_\_\_\_\_ < \_\_\_\_\_\_\_o

1. Calculate the experimental Zeq for the RC network by dividing the two quantities above. Remember, when dividing complex numbers in polar form, the magnitudes divide normally, but the phase angle of the denominator is subtracted from the phase angle of the numerator.

Experimental Zeq = **Vs/I** = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_<\_\_\_\_\_\_\_o (polar)

= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (rect)

Table IV Experimental RC Impedance Calculation at 3 frequencies

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Frequency, f** | **VS pp** | **VR pp** | **I pp**  | **T** | Δt **for VR** |  | ZEQ expermt(rect) | ZEQ expermt(polar) |
| 1000 Hz |  |  |  |  |  |  |  |  |
| 4500 Hz |  |  |  |  |  |  |  |  |
| 10000 Hz |  |  |  |  |  |  |  |  |

Please write a brief answer to the following questions:

1. How do the experimental results in Table IV compare to the theoretical results in Table I?
2. If there are errors, do they appear to be in the amplitude or phase angle of the impedance, or in the real or imaginary part?
3. Which do you think is the larger contribution to error when measuring impedance, the magnitude or the phase angle measurements?
4. How would you describe what impedance is, in your own words?

**PART 2 : Series RLC circuit [Optional, 3 points Extra Credit]**

Table V. Theoretical Impedance calculations for a series RLC network at 3 different
 values of ω. Recall that ω = 2πf. Show Zeq in rectangular and polar form.

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency, f | Frequency, ω |  |  |
| 1000 Hz |  |  |  |
| 4500 Hz |  |  |  |
| 10000 Hz |  |  |  |

Table VI. Experimental RLC Impedance Calculation at 3 frequencies

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Frequency, f** | **VS pp** | **VR pp** | **I pp**  | **T** | Δt **for VR** |  | ZEQ expermt(rect) | ZEQ expermt(polar) |
| 1000 Hz |  |  |  |  |  |  |  |  |
| 4500 Hz |  |  |  |  |  |  |  |  |
| 10000 Hz |  |  |  |  |  |  |  |  |

**Reflecting on your Results**

Please write a brief answer to the following questions in your datasheet.

1. How do the experimental results in Table V compare to the theoretical results in Table VI?
2. The 33 mH inductor has an internal winding resistance of about 50 Ω, which you can determine by connecting an ohmmeter to it. This internal resistance would add to the overall resistance of the circuit, diminishing the value of current I. If you incorporated this extra resistance into your value for R that you measured in step 1, would that bring your theoretical calculation of impedance closer to your experimental result, or farther away?