**Department of Computer and Electronics Engineering Technology**

**CEET 1140**

**Lab 9**

Title: Impedance.

Objective: The student will be able to measure the impedance of an unknown circuit at various frequencies using an oscilloscope.

Equipment: Function Generator
Oscilloscope (with 2 probes)
Proto Board
Black Box (Unknown Impedance)

Parts: 1 resistor in the range 50-100Ω, ¼ watt

Preparation: Write the title and a short description of this lab in your lab book. Make sure the page is numbered and make an entry in the table of contents for this lab.

Acquire a resistor in the range 50-100Ω. Measure the actual resistance of your resistor. Record this measurement in your lab book and bring it to your lab period.

Set up: In order to measure the impedance of an element, we will need to see waveforms for both voltage and current simultaneously, just as we did in Lab 8. Once again, we will add a resistor in series to measure the current, but this time we will not assume its effect is negligible.

Construct the circuit in Figure 1, using a black box in place of Z1. Connect one scope probe to point (a) and the other to point (b). Connect the scope ground clamps the circuit ground.

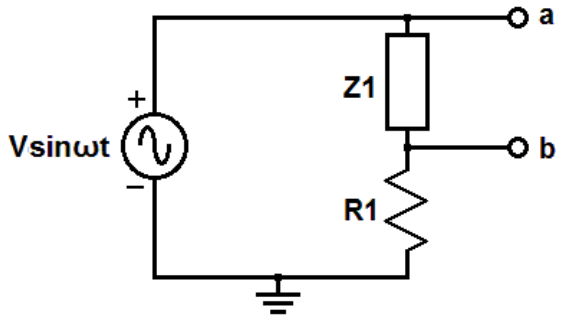


Figure 1. Circuit to Measure Impedance.

Turn on the function generator, and configure it to produce a sine wave with a frequency 5kHz. Adjust the amplitude to ±4V.

Comment: The objective is to find the impedance Z1. To do that, we will first find the impedance of $Z_T$ = Z1+R1, then, since R1 is known, it is straightforward to solve for Z1.

Procedure: Using the voltage cursors on the scope, measure $V_m$ and $I_m$. (Don't forget to divide by R1 to get $I_m$.)

Assume the phase angle of the voltage waveform is 0°. Find the phase angle of the current waveform, θ, using the time cursors on the scope. (It is usually best to measure the time from the zero-crossing of one waveform to the zero-crossing of the other.)

Calculate the impedance, $Z_T = (V_m \angle 0°)/(I_m \angle \theta)$.

Convert $Z_T$ to rectangular coordinates and compute $Z1 = Z_T - R1$. Record that value in a table. Repeat the measurements and calculations for 10kHz and 20kHz.

Assume the black box consists of a resistor in series with a capacitor or an inductor. Then Z1 = R±jX, which means the resistance and reactance can be found directly from the rectangular form of Z1. Use the reactance of Z1 (at your choice of frequency) to find the size of the inductor or capacitor inside the black box.

Cleanup: Turn off the power and return the second scope probe.

Conclusions: In the conclusion section, write a short summary of what you did and what you learned. Make sure your conclusion answers the following questions:

Is your unknown impedance more capacitive or inductive?

Which part(s) of the impedance depend on frequency? The real part, the imaginary part, or both?