Department of Computer and Electronics Engineering Technology

CEET 1140

Lab 7

Title: Inductors, Time Constants and Frequency Response.

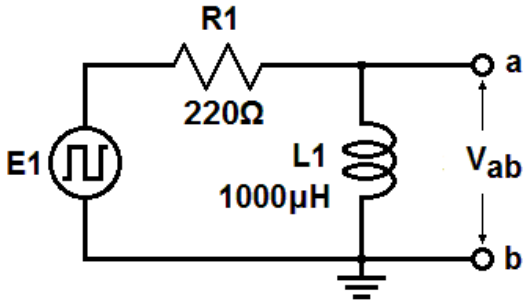
Objective: The student will be able to construct an RL circuit and measure its time constant and its frequency response.

Equipment: Function Generator
Oscilloscope
Proto Board

Parts: 1 220Ω Resistor, ¼ watt
1 1000μH Inductor

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.

Calculate the time constant, τ = L/R for the resistor-inductor network shown below:



E1 is a voltage source that generates a square wave. Calculate its period, T, so that it is "high" for 5τ and "low" for 5τ. This period will insure that the voltage, V_{ab}, will stabilize between each transition. Find the frequency, f, by computing f = 1/T.

The governing equation for the current through an inductor in an RL circuit is $i = i_f - (i_f - i_i)e^{-t/\tau}$, where i_i is the initial current and i_f is the final current. Once the current is known, you can find any voltage in the circuit using Kirchhoff's Voltage Law.

Assume E1 generates a square wave that alternates between -5V and +5V and that the voltage stabilizes between each transition.

Use the equation above and Kirchhoff's Voltage Law to calculate the voltage, V_τ, across the inductor at time $\boldsymbol{\tau}$ after the voltage source switches from -5V to +5V. (Note, for this calculation, i_i = -5V/1KΩ = -5mA, and i_f = 5V/1KΩ = 5mA)

Record these calculations in your lab book and bring it, along with the parts, above, to your lab period.

Set up: Connect the function generator directly to the oscilloscope (no not use the TTL output). Turn on the power and configure the function generator to produce square waves. Adjust the frequency to the frequency you recorded in your lab book. Adjust the amplitude so that the voltage alternates between +5V and -5V (for a total voltage swing of 10V).

Construct your RL circuit using the function generator in place of the voltage source. Connect the black lead (wire) to ground. Connect the scope probe to point (a) and connect the scope ground clamp to point (b).

Procedure: Using the cursors on the scope, measure the time it takes for the voltage on the inductor to drop back to V_τ after it "spikes." This time is the measured time constant. Compute the error (in percent) between this value and the time constant, $\boldsymbol{\tau}$, you computer earlier.

Move the scope probe back to the function generator. Note how this new waveform differs from the one you saw when you adjusted the function generator.

Move the scope probe back to point (a). Switch the function generator so that it produces a 20kHz sine wave. Note the shape of the waveform displayed on the scope. Using the cursors on the scope, measure the peak voltage and record it in your lab book. Repeat this measurement with frequencies of 4kHz, 8kHz, 16kHz, 32kHz and 64kHz. Graph the frequency response of your circuit by plotting the measured voltage for each frequency.

Cleanup: Turn off the power.

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:

Was there a difference between your computed and measured $\boldsymbol{\tau}$? What might explain this difference?

Why does the output of the function generator change when it is connected to the circuit? (Hint. The function generator has an internal resistance of 50Ω.)

Describe the relationship between the frequency and V_{ab}. How does this compare with the relationship you observed for the capacitor in Lab 6?