Department of Computer and Electronics Engineering Technology

CEET 1140

Lab 6

Title: Capacitors, Time Constants and Frequency Response.

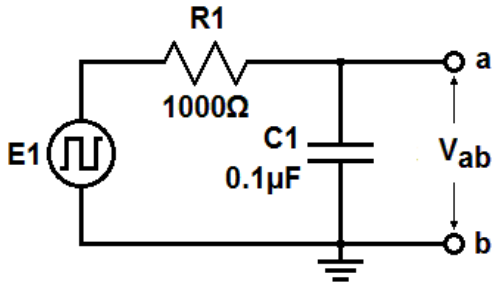
Objective: The student will be able to construct an RC circuit and measure its time constant and its frequency response.

Equipment: Function Generator
Oscilloscope
Proto Board

Parts: 1 1000Ω Resistor, ¼ watt
1 0.1μF Capacitor

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 = RC for the resistor-capacitor 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 to the voltage on E1 before each transition. Find the frequency, f, by computing f = 1/T.

The governing equation for an RC circuit is $v = v_i + (v_f - v_i)e^{-t/RC}$.

Assume E1 generates a square wave that alternates between -5V and +5V and that the voltage stabilizes before each transition. Use the equation above to calculate the voltage across the capacitor at time τ after the voltage source switches from -5V to +5V. Call this voltage V_τ. (Note, for this calculation, t = RC, v_i = -5V, v_f = +5v.)

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 RC 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 capacitor to change from -5V to the V_τ you computed earlier. This time is the measured time constant. Compute the error (in percent) between this value and the time constant, $\boldsymbol{\tau}$, you computer earlier.

Switch the function generator so that it produces a 400 Hz sine wave. Note the new the shape of the wave 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 800Hz, 1600Hz, 3200Hz and 6400Hz. Plot the measured voltage for each frequency on a graph. This graph shows the *frequency response* of the circuit.

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?

Describe the wave shape of V_{ab} when you changed the function generator to produce a sine wave.

Was the voltage you measured across the capacitor the same for all the frequencies you tried? If not, describe the relationship between the frequency and the voltage.