EGR 220 Lab 5 March 4

Theme: Dynamic Circuits & the Time Constant

To explore the concept of a time constant, τ. To understand what a time constant is and how it explains the dynamic behavior of RC circuits.

Background

The concept of a time constant, τ, was introduced in class. This is the most fundamental characteristic of RC and RL circuits (one resistor and one storage element: a capacitor or an inductor). For lab you should focus on capacitors, rather than inductors. For an RC circuit, τ, in units of seconds is: τ = RC.

You might want to read through sections 7.1 and 7.2 in the text for additional theory behind RC circuits. We will cover this in class on Tuesday.

Possible Experiments

- Design and build a circuit that contains at least one resistor and one capacitor (we do not have a good selection of inductors).
- **A GREAT EXPERIMENT: INVESTIGATE THE CHARGING AND DISCHARGING BEHAVIOR OF AN RC CIRCUIT.**
    - Be sure to include an investigation of the concept of 'time constant' in your experiment(s).
- *The passage of time* will be an element with these circuits, as these are 'dynamic.' This is to say, you might want to think about (and measure)
    - How different circuit variables (voltage and/or current) change over time?
    - How do different valued resistors and/or capacitors change your circuit's behavior?
- We have many capacitors in the lab, but be ready to be flexible with the values you use once you are actually in lab and see what is available.

Things to Consider

- What is the expected behavior of the charging and discharging of a circuit storage element?
    - Did you observe this behavior in lab?
- ***Why*** is this the expected behavior? What does this behavior tell us about the universe we live in?
- How does the circuit behavior you observed, in terms of voltage and current in your circuit, challenge and/or deepen your understanding of our questions of understanding:
    - What is voltage? (what is a voltage drop and what does it mean to have this voltage drop be a dynamic quantity?)
    - What is the relationship between voltage and current?

Lab Equipment To Use

- Start with using the DC power supply and multimeter, as you have for our previous labs. Record Voltage and/or Current values from the multimeter, for your circuit, using a stop watch or clock.
    - Think about how often you want to record a measurement. Every time constant? Every quarter time constant? Every 5 seconds?
    - In the lab memo, plot this data using a computer (excel, matlab, etc.)
- You might also want to use the function generator and oscilloscope for this lab, but if you do this, you will need a new circuit with a short time constant.
    - If you don't plan this out in the pre-lab, I will happily work with any team that does want to explore this option.
    - You will definitely use the function generator and oscilloscope for next week's lab.
    - **You MUST use a USB drive** to capture and present any results from the oscilloscope if you are using the scope
        - Bring a flash drive, and I will show you how do get your pictures.
        - Do not use photos taken with your phone or other camera.
    - Suggestion for the function generator: Use input voltage of at least $1V_{pp}$ (not $100mV_{pp}$) to be able to record good data for the circuit behavior.

Notes for the Lab Memo

- Make sure your lab memo will communicate to *any reader* what you did and found.
    - Keep the *text* to essentially one page, but you can go over one page with the addition of circuit diagrams, graphs, equations, etc.
- Report your results with words, equations, numbers… *and graphs*
    - You MUST include plots with this lab memo, including graphs from data you record by hand (and plot professionally with a computer) and any saved .png figures from the oscilloscope
        - No pictures from a phone or other camera
    - With *every* figure (graph, plot…) you must explain to the reader why the figure is there, what is interesting about it, what it explains, what it shows, etc.
    - If you do not point the reader (me) to your figure, the reader might not look at it.
    - You need to do the intellectual work of explaining what is interesting or important about your figure, and not leave that to the reader to figure out on her own.