Metacognition

Intro to Metacognition

What Is Metacognition?

Metacognition is thinking about thinking, typically to improve or control thought. Students with better metacognition perform better in school, work, and social groups. Here is an example of how living with metacognitive skills can impact your life:

When Rollo was in college, he had difficulty paying attention in lectures. He asked his friends what they did to pay attention in class. He tried their advice of taking notes, drinking lots of caffeine, recording the lecture, but found they only helped a little. Eventually, Rollo realized he didn't care about what the professor was saying, but he did care about how he could apply the concepts to his personal projects. This made the lectures interesting, and helped him learn the material.

Rollo applied metacognition by: 1. Identifying the problem: He couldn't pay attention, 2. Learning: he talked to his friends, 3. Trying: doing new things, 4. Reassessing: reviewing what worked and why.

It's easy to miss how mistakes relate to each other. Struggling to do your homework? It might be related to motivation, attention, or time management. You can promise yourself to 'try harder next time' but unless you take time to recognize the pattern and look for solutions, the underlying problem will remain. Understanding why you're making mistakes and addressing them early helps you improve in many aspects of life, including this Circuits course. Metacognition takes practice, so in this course we'll practice explicitly. However, we also encourage you to practice this in other classes and in life in general.

How to Use Metacognition

1. Identification: What do you want to do? Have you done this in the past? What is this most closely related to? How did it go? Does this happen a lot? What about in other parts of your life?
2. Learn: Think about what happened last time. Look up suggestions online. Ask a friend. Ask a mentor.
3. Try: Try whatever you think is best.
4. Reassess: Did it go better or worse than last time? Why do you think that? What are you going to do differently next time?

Practice in This Course

Metacognition is helpful, but only if you actually practice and apply it. As such we're incentivizing these in this class. Keeping a regular journal that is complete will be counted as extra credit (value and placement of extra credit will be decided toward the end of the course). To get it you must have at least 3 entries for each Milestone for Omega Labs or 3 entries per unit for Alpha Labs. Course-specific reflections have no minimum or maximum number of entries. They are a reflection on any activity in the course that impacted you in some way. They can be rare or frequent. The plus, delta, kaizen exercise concisely expresses your reaction and action plan as a result of something done in the course!

Metacognition Lab-related entries must include:

- The date
- What task are you doing?
- What is something new worth trying?

After you're done, append to the end of the entry:

- How did it go? And how do you know?
- Did your new strategy work?
- What else do you need to learn?
- What are you going to try next time?

Course-Specific Reflection must include (these can be rare or frequent):

- The date
- Topic and/or name of content
- Plus
    - Anything that was great about an exercise, class, or assignment
        - (***Be honest, hurting feelings or gaining some advantage by being nice is not possible here!***

    - Anything you learned that you didn't know
    - Anything you knew but really resonated with you and you got a deeper understanding

- Delta
    - Anything that could be improved
    - Anything statement made you disagreed with
    - Any question you have that wasn't addressed that should be addressed
    - Anything you were confused about or was too high level to understand
- Kaizen
    - One thing you plan to do or take action about because of the in-class exercise or topic
        - Look up a definition
        - Look up the research page
        - Review material from a class you already took
        - Talk to Sawyer, TA, or other professor (Braunstein is great too!)

Entries (Start here after reading background above!)

Date and Lab/Course Topic

(please continue to make this heading 3 and update table of contents for easy navigation)

1/29|Alpha Lab 1|Polarity

We are tasked with defining polarity in LTSpice. I know some components in real life have to be polarized like some forms of capacitors. I wonder how the LTSpice code will actually handle the polarization of components. Because I'm a CS major I'm gonna guess that how they define each object is based around their terminals, and their current defining method looks for terminals and valid paths. It then defines voltages and current flow from seeing what terminal it sees then which one it exits.

It's after the lab and I am pretty sure my guess was correct. What we did to determine polarity was essentially draw a circuit with 2 resistors and record the primary values. Then based off my previous hunch I just flipped the bottom resistor and observed what happened. To my surprise it actually works. I made the current flow from the negative terminal of the resistor to positive which means negative voltage across it, and we observed this. For the rest of our circuits we are going to have to pay close attention to the poles of the components. One thing to try for next time is observe how the object is spawned in and then observe how it rotates with CTRL+R shortcut.

2/12|Alpha Lab 2|Superposition

We are tasked with proving the concept of superposition. In my terms it means adding up the desired values after individually calculating what it is for each source in the circuit. In class we are supposed to draw the new circuit each time but I am going to try deleting wires from the circuit in LTSpice and hope it doesn't complain.

Well thankfully my new method worked. It seems that LTSpice can handle unconnected or floating wires and not crash. That saved quite a bit of time. The group worked exceptionally well this time around. The first Alpha Lab was incredibly long and tedious, as we did not know what we were doing. This time around we each were able to assign roles and topics to each other and we coordinated more effectively. For future improvements we may want to look at how we can potentially simulate multiple smaller circuits in 1 LTSpice file to save time on assignments.

2/12|Alpha Lab 2|Voltage Division

We are tasked with finding an interesting use for a voltage divider. Quite the challenging topic because what else do you use a Voltage Divider for? It's like asking to find an interesting use for a drill other than drilling. Despite that issue, I do know that a voltage divider can be used to create a reference. We might be able to try using that reference for other analysis purposes.

Turns out the reference thing made a bunch of sense. Voltage Dividers are inherently used in wheatstone bridges and the voltage across the bridge can be changed. When it is 0 you are solving for an unknown resistor but we can also make it positive or negative. We realized this can be used as a comparator of sorts. A lab partner came up with the idea of using the potentiometer as a control mechanism for a comparator. For the future when we use components that have changing impedances it would be interesting to see how we can incorporate those into our design. I have heard the concept of an AC voltage divider and would like to see how that can be implemented.

2/18|Omega Lab MS2|Advanced Op-Amps (Integrators)

We are tasked with proving the function of an Op-Amp with a capacitive feedback loop. We have switched to omega labs and faced some problems figuring out which problem we wanted to tackle. Once we did figure that out we decided that an integrator op amp makes the most sense. Figuring out how a circuit actually does a function is quite strange. I think this time around we might use a simulation software called Falstad to run our circuit and try to understand it from there.

Falstad was a great choice, but it became clear why it may not be the perfect choice. Using the real time scope of the Falstad simulator means that we were able to tinker with our circuit in real time to analyze how it works. This was great for our integrator because our integrator was working with a random signal of essentially noise. Simulating noise in LTSpice is quite hard. One thing we didn't account for was that the integral was actually negative. We may need to learn how to make a non-inverting integral op amp. We must test this design in the future.

4/7|Omega Lab MS2|Differential Equations

Differential Equations are much easier this far into the course. We are tasked with analyzing an RC circuit using differential equations. It might be easier this time around to just guess the equation like we've done in class a few times, as opposed to using KVL for this RC circuit in particular. The 555 timer circuit is quite standard.

Guessing saved so much time. Because it was just a simple series RC circuit there were enough initial conditions to just guess for the differential equation. The equation and simulation and measurement were very similar, almost to an uncomfortably close level (from the perspective of other circuits done in lab). We do not know if we need to use differential equations to solve any other elements of our circuit. It may be necessary for some MS3 concepts but we are not sure. It may be helpful to learn the process of solving the equations in parallel with a lot more components. Or it might be better to do it with Laplace Transforms.

4/14|Omega Lab MS2|Laplace Transforms

Time to analyze the same RC circuit with Laplace Transforms. I have a better hang on Laplace transforms this time around. We are going to try using KVL to find the voltage across the circuit. You can't really guess with Laplace transforms so it might be necessary to use the base line circuit analysis concepts. It's one loop so I don't think Mesh analysis would scale well with this specific circuit.

It turns out, I am not very cognisant of the things we learned in this class. In reality, instead of having a 3 variable KVL equation I could just use a voltage divider. New strategy did not work this time. I am glad my group came together halfway through and gave feedback on our process for each element. If we do need to use differential equations in MS3 then I will just switch to Laplace transforms and try using circuit reduction to solve my problems. Next time we plan to communicate more as a group. We need to look over each other's work for at least 2 minutes to make sure that all of us are working as efficiently as possible

4/22|Omega Lab MS3|Transformers

MS3, yay. Homestretch. We are trying to prove the concept of transformers. In theory I know the transformer conserves power and either increases the voltage across the secondary or the current through the secondary. We have a wall adapter stripped and bread board ready. We know there is a transformer in that circuit so we are going to try modeling that components functionality for analysis purposes.

Great, yet not so great idea. Turns out that companies want to keep their product schematics a secret. However a lot of research and a bit of thinking got us to understand how that component works, at least at a basic level. We learned about regulator chips, and 3 phase systems. However this is too simple to be industry standard. We need to learn about how to optimize a circuit like this, so that it does not waste too much power. In addition we need to be able to explain how the switch in power supply actually supports that range of voltages.

4/29|Omega Lab MS3|Filters

Time to prove how filters work. This is probably going to be the largest challenge for us to overcome. Our circuit does not have a clear use for a filter, especially for AC voltage. We are going to try a high pass filter because a high volume of cars is probably the most reasonable for checking when there is a lot of pollution.

This was so incredibly hard to do. For most of the semester we never had too many design problems, or problems figuring out why LTSpice was doing what it was doing. Our strategy did not work at all. First thing we realized that the amount cars passing by in second is quite a small number in terms of the vast range of frequencies a lot of filters can be designed for. In addition, cars do not fly by at 50Hz, so a low pass filter made more sense. This made us sensitive to realistic car frequencies. The next problem was using a square wave. Turns out that square waves are just sine waves because of a nifty tool called the Fourier Transform. The sharp edges of the waveform went right past our filter triggering our circuit. Thankfully switching to a low pass filter also solved this problem for some reason. So at the end of the day we need to learn about Fourier Transform waveforms, other types of filters that can filter out square waves, and how to build an incredibly small range band pass filter. Designing something like that can be used next time.

5/3|Omega Lab MS3|Design Principles

This isn't necessarily a circuits concept but it is an engineering concept that we discussed way back in the beginning of the semester. We discussed why we build our circuits, and the effect they can have while trying to solve the problem. In addition we talked about building robust circuits that can be used outside of a lab environment. We are going to try using tools not talked about in this class to make our circuit better.

Everything we tried was new with varying degrees of success. Our best change was using transistors as a check valve for the rest of our circuit. We had an issue of small DC voltage passing through to our integrators messing with calculations. The non-ideal part of the transistor (0.7V on voltage) solved this problem, so our circuit turned only when we sent our actual signal to our integrators. In addition we tried using a voltage follower for our circuit to preserve the integrity of our filter. It did work, but it wasn't truly necessary. Having the extra current draw from the op amp didn't make sense because the 555 timer chip had its own tolerance that our filter always operated in between. In the future we may want to design better filters, power our op amps with a higher range of voltages, and even protect against EM interference.

Course-Specific Reflections

1/25|Nodal Analysis

-Plus

Well the examples made sense. Figuring out nodes in the circuit is simple enough. The matrix equations seem weird.

-Delta

I wonder what happens when you have a source not connected to ground or how current sources affect this. Prof saying she doesn't like Nodal also didn't help.

-Kaizen

Nodal Analysis is not my favorite after doing some examples. The coefficients are just not intuitive. I have a hunch that the KCL parts will be useful for future circuits so I think I will need to go to TA's to figure out the specifics.

3/1|Laplace Transforms

-Plus

Well at least we aren't just guessing equations or manipulating the circuit to get it into a standard form. Turns out $s = j\omega$ at least when looking at impedances.

-Delta

This is all internal, but Laplace Transforms are really tough for me because I never actually learned partial fractions and whenever I had to be really good at manipulating in s-domain I usually faltered. So I normally skipped those questions in diff eq. Going over some advanced s-domain analysis and simplification might be useful.

-Kaizen

Back to office hours we go. In addition I would probably try watching the videos to just see some examples.

4/10|Level Up Problems

-Plus

These rock. They allow me to get the process down for questions super fast. I can skip around and see various configurations of problems. Furthermore it is great that these are test level questions.

-Delta

Not much to be said here. I think that the best thing that could be improved upon is video quality. 2020 is one heck of year to be using mics from the early 2000s. Also, not making mistakes halfway through a solution would help when you are jumping around to just get a specific process down.

-Kaizen

Talking about the problems with prof in office hours is something that I will definitely do.

4/27|Course Ending

-Plus

This is just going to be a reflection on the course. I think the course is great, but really hard. I think despite COVID-19 the course was still robust and I learned quite a bit. Level up problems are great. The TA's are great.

-Delta

Omega labs took a big hit and became the most stressful part of this course. That's about it. Prof might need to work on her hand writing. Updated videos would be nice and also not making mistakes in the video would be swell.

-Kaizen

I am glad that this information will be available always because this course taught the fundamentals so well that I think I will be coming back to this a couple times more than I would like to.

Have a good one everyone!