LAB 06 — 03/06/2025

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Introduction:

Circuitry is an essential component of almost everything in our daily lives, ranging from the relatively simple circuits seen in a flashlight to the hardware that enables the functionality of the computer that is being written on. Despite the complexity, much of the physics that allows these systems to work share a few core concepts. Within this lab we intend to investigate these concepts, specifically relating to voltage, current and resistance, and investigate the impact of different components when placed in either series or parallel circuits.

Problem 1: Building A Circuit

Materials:

- Genecon
- Alligator Clips

Methods/Procedures:

The terminals of the genecon were connected using alligator clips. This created a closed circuit. The genecon was then cranked to create a potential difference. The alligator clips were then disconnected to create an open circuit between the two terminals.

Data/Results:

When the circuit was closed, the crank was more difficult to turn. When the circuit was open, the crank was easier to turn.

Data Analysis:

The crank was harder to turn when the circuit was closed because current was being drawn. The crank was easier to turn during an open circuit because a potential difference did not require work to be maintained. The current being drawn through the wire indicates that there is some small resistance in the wire.

Problem 2: Series vs Parallel

Materials:

- Genecon
- 3 x Light bulbs
- Alligator Clips

Methods/Procedures:
Assemble the lights in a series circuit, which is then connected to the terminals of the genecon. The genecon was then cranked. The circuit is reassembled, though now with the lights in parallel. The genecon is again cranked.

Data/Results:
The lights were brighter and the crank was found to be harder to turn when the circuit was in parallel.

Data Analysis:
It was easier to crank the three bulbs in series because the equivalent resistance is higher so the current will be lower with the same voltage. The brightness of the bulbs was lower because $I = V/3R \Rightarrow P = I^2R = V^2/9R$. It was harder to crank the three bulbs in parallel because the current draw was higher because the voltage was the same but the equivalent resistance was lower. The bulbs were the brighter in parallel because $I = 3V/R \Rightarrow P = I^2R = 9V^2/R$.

Problem 3: Series and Parallel

Materials:
- Genecon
- 3 x Light bulbs
- Alligator Clips

Methods/Procedures:
Assemble a circuit with two bulbs in series in parallel with another bulb. The genecon terminals are then connected and the Genecon is then cranked. A second circuit is assembled with two bulbs in parallel in series with a third. The genecon is then cranked again.

Data/Results:
For the first configuration, the lights in series were less bright than the light they were in parallel with. For the second configuration, the two in parallel barely light at all while the one in series with them light up a lot.

Data Analysis:
The reason for the brightness difference in configuration 1 is the same as in problem 2. The two in series were dividing each other's voltage while the one in parallel was not having its voltage divided. For configuration 2, the one bulb in series was so much brighter because it was drawing way more of the voltage and the same current because the equivalent resistance of the two in parallel is half of R. This made it so that the one bulb was drawing most of the power at the same voltage.

Problem 4: The Capacitor

Materials:

- Genecon
- Supercapacitor (1 F)
- Alligator Clips

Methods/Procedures:

The Genecon is connected in series using the alligator clips with the capacitor and cracked for some time. The force to crank the Genecon over time is noted. A lightbulb is connected in series then, and the same data are noted.

Data/Results:

The force required to crank the Genecon reduces with time as the capacitor charges. When it discharges, the Genecon moves on its own as the capacitor releases the energy stored prior. When the lightbulb is connected in series, the capacitor doesn't charge or discharge very fast at all.

Data Analysis:

The fact that the force for the Genecon goes down over time implies that the current across the capacitor goes down over time. This makes sense, since capacitors can only hold so much charge without discharging (meaning the current needs to be reduced to not overcharge the capacitor). The discharged current is also what moves the Genecon on its own. The lightbulb activates like normal while the capacitor seems less functional, which makes sense comparing the resistance of the capacitor to the lightbulb, and resulting voltage fraction between each.

Problem 5: A Generator, or a Motor?

Materials:

- 2x Genecon
- Alligator Clips

Methods/Procedures:

The two genecons are connected using alligator clips. One genecon is cranked while the other is held by the handle to allow spinning. A lightbulb was connected between the two genecons. The genecon was cranked while the other was held by the handle. The genecon was then cranked while the other was held by the crank and handle to prevent spinning.

Data/Results:
When the first genecon was cranked, the handle of the second one spun the same direction as the crank. When the lightbulb was connected but the handle was free, the handle of the other genecon spun the same as before but the light did not light up. When the hand of the other genecon was stopped, the light lit up.

Data Analysis:
The reason that the genecon handle spins the same direction as the cranking is due to the torque exerted on the handle. When it is being cranked, the torque on the handle is opposite of when the current is flowing through it despite the movement being the same, this is because the inner force of the genecon is pushing back against cranking. The same thing happens when the lightbulb is connected. It does not light up because the genecon is drawing all the power. When the handle is stopped, the genecon draws far less power so the light draws most of the power and lights up brightly.

Conclusion:
In this lab we investigated the core concepts shared by all circuits, being voltage, current and resistance. Starting by determining that the crank will become harder to turn the more current draw it needs. We then saw firsthand how placing sources of resistance in either series or parallel can either decrease or increase current required and the resistance of the crank, for a similar level of brightness. We also blurred the line between generators and motors, where by applying power to the Genecon, it began to turn on its own. These concepts are essential to understand for designing any form of circuit for engineering purposes.