Electronics Laboratory

Winter semester 2025

Lab 1 – Diodes

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Score and comments (only for tutors, please leave blank)

Please fill out this cover sheet and submit it with your lab report.

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Electronics Laboratory
WS 25/26
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Lab 1 - Diodes

12. November 2025

1.2 A Variety of Diodes

1.2.1 Simulation

The goal of the Simulation is to measure and plot the characteristics of different Types of Diodes, in this case one Si Diode (Model: 1N4148), one Schottky Diode (Model: BAT41) and one Zener Diode (Model: ZD3V9).

Circuit Diagrams:

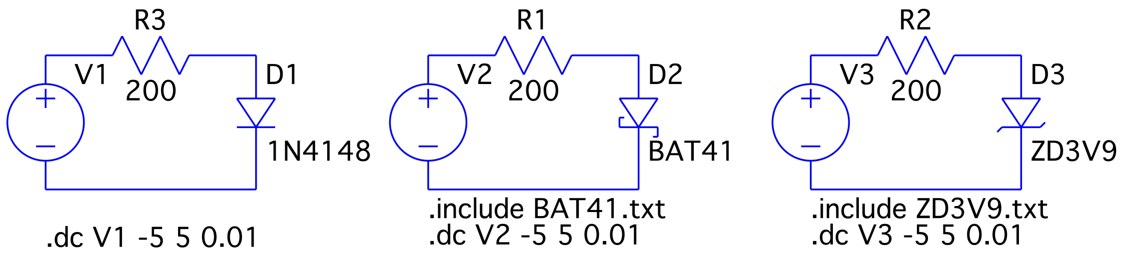

Figure 1: Circuit Diagrams from LTSpice[1]

Plots:

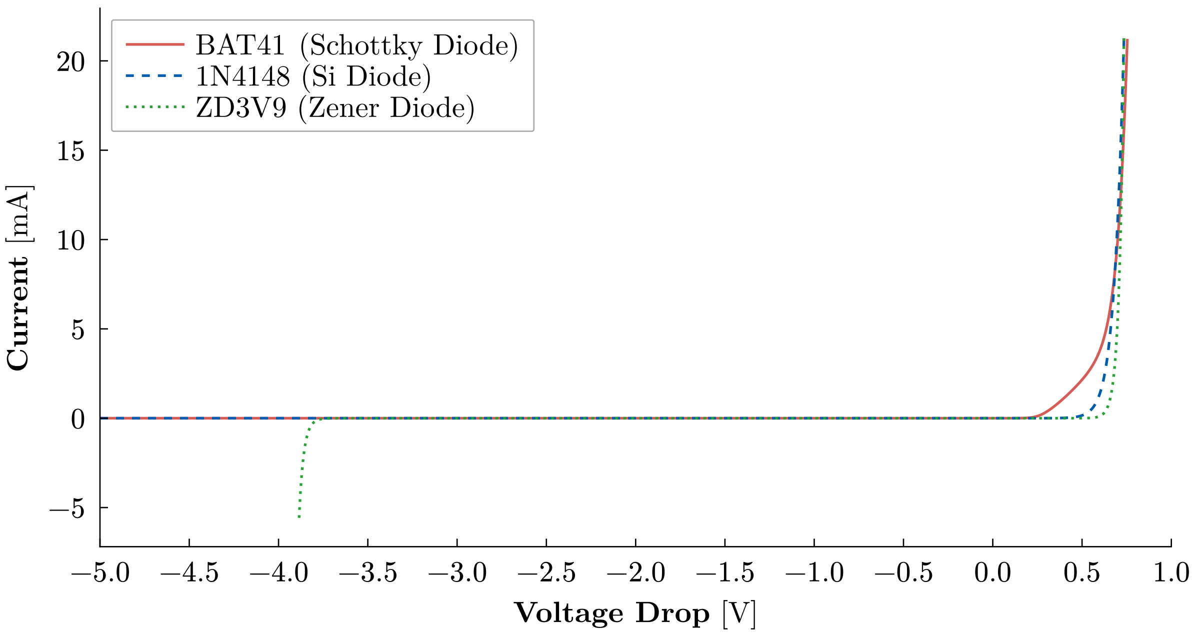

Figure 2: Simulated IV-Curves of all three Diodes

[1]We had a back and forth with adding ground, and ending up connecting ground to minus in the final result, it is missing in the diagram

Text Questions:

(f) Small-Signal Resistance r_D for $|I_D| = 20$ mA for:

- 1N4148 Diode is $r_D \approx \frac{1}{0.35344} \approx 2.83\ \Omega$
- BAT41 Diode is $r_D \approx \frac{1}{0.2892} \approx 3.46\ \Omega$
- ZD3V9 Diode is $r_D \approx \frac{1}{0.77504} \approx 1.29\ \Omega$

(g) One essential difference between the characteristics is the breakdown voltage, which for the Schottky diode is ≈ 0.3 V, for the Si diode is ≈ 0.6 V and for the Zener diode is ≈ 0.7 V.

Also, the Zener Diode has the classical Zener-Curve in the negative voltages, having a reverse breakdown voltage of ≈ 3.8 V, whereas the other ones stay at 0.0 A.

Conclusion:

We explored the IV-Curves and characteristics of the different types of diodes.

1.2.2. Measurement

The goal of the measurement is to verify the Simulation we created in the previous exercise.

Circuit Diagrams:

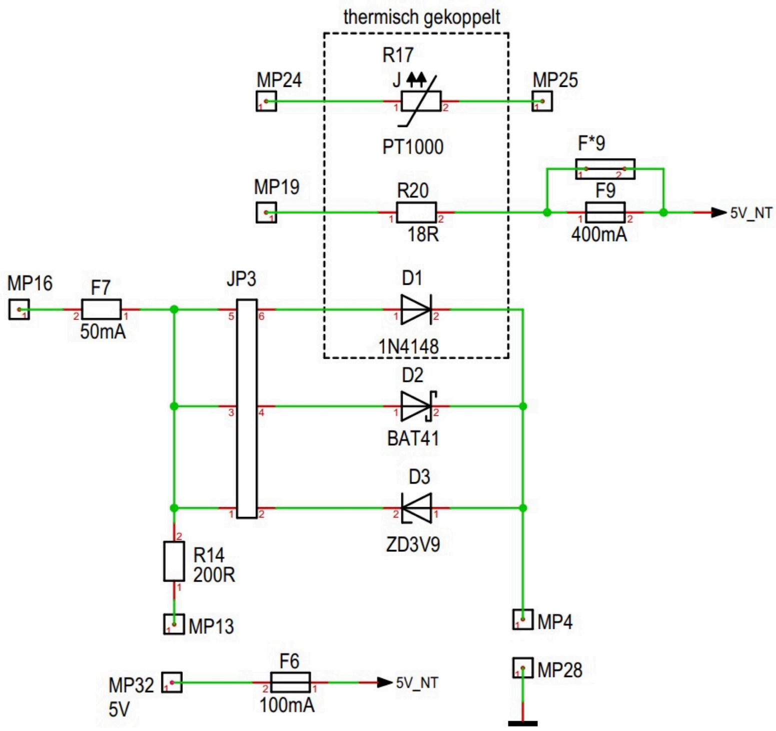

Figure 3: Schematic of the diode characteristics circuit

Plots:

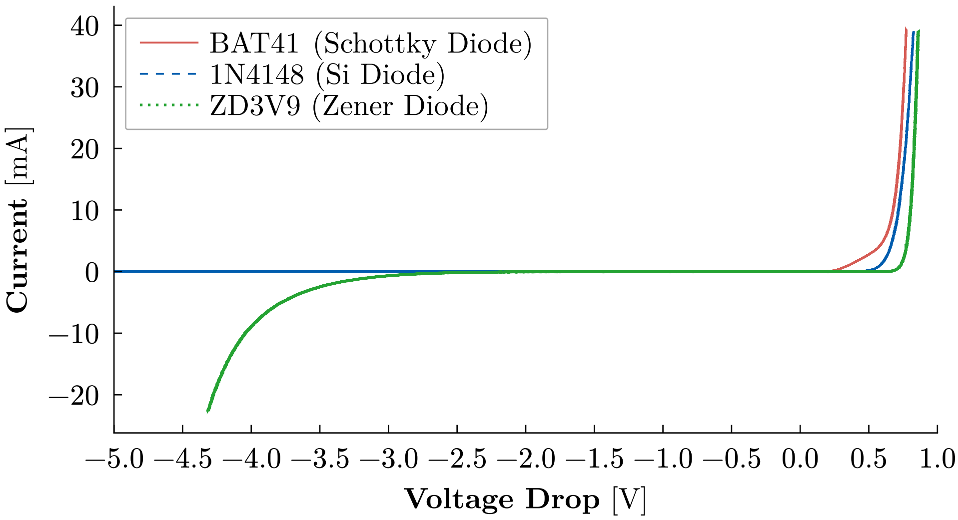

Figure 4: Measured IV-Curves of all three Diodes[2]

Text Questions:

(a) The true value of $R_{14} \approx 199.1\Omega$

(b)

Diode	**Forward Bias** [V]	**Reverse Bias**[3][V]
$D1$ (1N4148)	0.612	0
$D2$ (BAT41)	0.382	0
$D3$ (ZD3V9)	0.712	≥ 2

The results of $D1$ and $D2$ look fairly similar to the simulation, but all the diodes did read slightly higher voltages when measured in reality.

The Zener Diode (D3) was very different in real life, because the multimeter only operates to 1.99V in Diode Test mode, so we could not read the value for reverse bias, which was approximately $3.85V$ in the simulation.

(g) In Forward Bias, the IV-Curve grows exponentially for all of the diodes (The Zener Diode is reversed on the board however). In Reverse Bias, the Curve stays at 0 for the Si and Schottky and grows to -inf for the Zener Diode.

(i) Small-Signal Resistance r_D for $|I_D| = 20$ mA for:

- 1N4148 Diode is $r_D \approx \frac{1}{0.005} \approx \ 200\ \Omega$
- BAT41 Diode is $r_D \approx \frac{1}{0.0025} \approx 400\ \Omega$
- ZD3V9 Diode is $r_D \approx \frac{1}{7.706} \approx 0.13\ \text{m}\Omega$

Conclusion

We measured and compared the real-word IV-Curves of the three different diodes, compared our results to the simulation and found similar results in the IV-Curves. For r_D we struggled with OriginPro for the derivative and therefore have really dubious Values.

[2]Zener Diode mirrored at (0, 0) for better visual

[3]≥ 2 means we could not measure it with our multimeter as the maximum ‘diode test’ can do is 2V

1.3 Light-emitting diodes

1.3.1 Simulation

The goal of the simulation was to visualize the IV-Curves for a green, a red and a yellow LED.

Circuit Diagrams

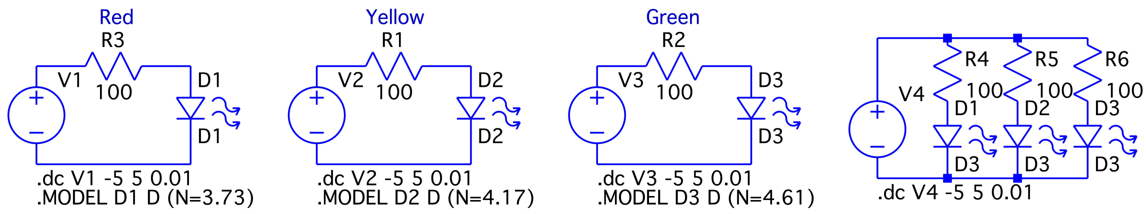

Figure 5: LED Circuit Diagrams from LTSpice

Plots

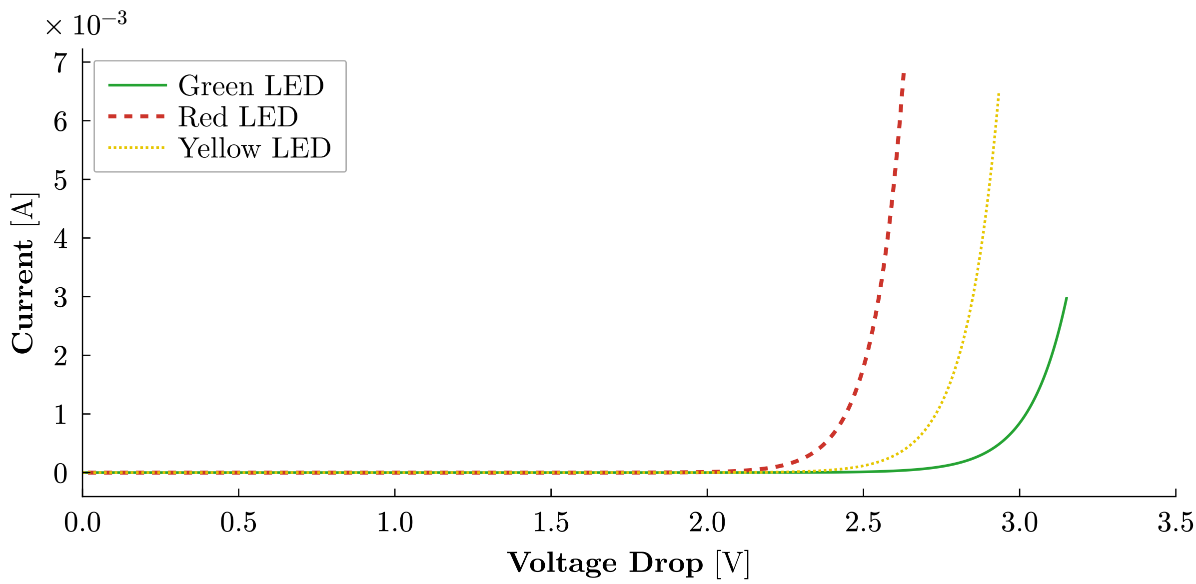

Figure 6: LED IV Curves

Text Questions:

(b) V_f-Values:

- Red LED ≈ 2.5V
- Yellow LED ≈ 2.8V
- Green LED ≈ 3.1V

(c) Red is the brightest LED, then yellow and then green

Conclusion

We successfully measured the IV-Curves of the three different-colored LEDs and looked at their relative brightness.

1.3.2. Measurement

The goal of the measurement was to see the LED Brightness and to mesaure the LED characteristics.

Circuit Diagrams

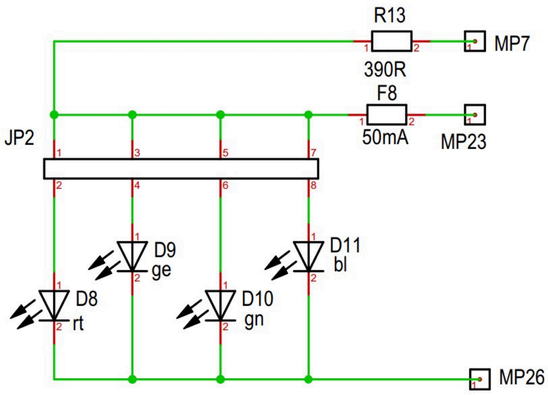

Figure 7: Schematic of the LED characteristics circuit

Text Questions

(a) V_f measured with handheld multimeter

LED	V_f [V]
$D11$ (blue)	≥ 2
$D10$ (green)	1.858
$D9$ (yellow)	1.828
$D8$ (red)	1.760

(f) Relative brightnesses of the different LEDs

Kombination (L & R)	LED 1 (L)	LED 2 (R)
$D8$ & $D9$	Bright	Bright
$D8$ & $D10$	Bright	Not so bright
$D8$ & $D11$	Bright	Off
$D9$ & $D11$	A little less bright	Off
$D10$ & $D11$	Dim	Off

(g) Red has the smallest breakdown voltage, so it is the brightest LED in all configurations. The voltage of the yellow LED is a little more, and we see that it is a little more dim than red when connected with the blue one. The green LED has an ever higher one, so it is quite dim, blue is even more and never turns on.

Conclusion

We could see all simulated effects in real-world brightness and verified V_f with a handheld multimeter.

1.4. Temperatur dependence

1.4.1. Simulation

The goal of the simulation was to see how the diodes behave under different temperatures.

Circuit Diagrams

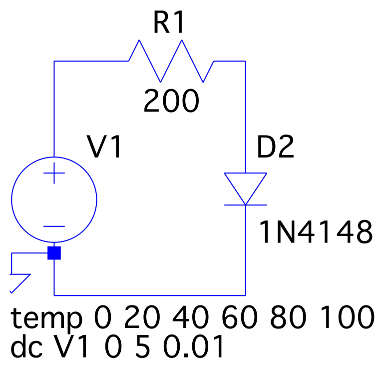

Figure 8: LTSpice circuit diagram of Temperatue Sweep

Plots

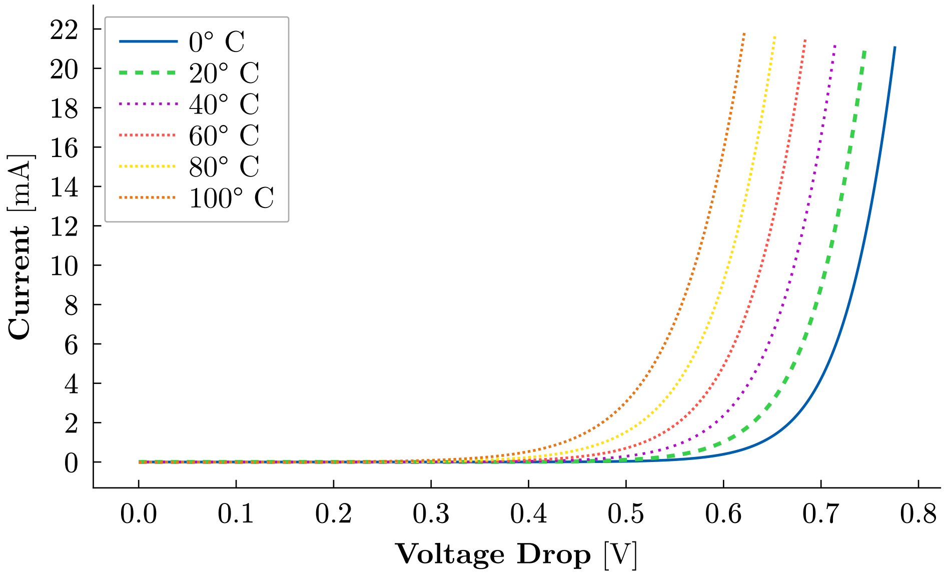

Figure 9: Diodes under different operating Temperatures

Conclusion

We could clearly see the differences in operating temperatures.

1.4.2. Measurement

The goal of the measurement is to see the influence of the temerature over the diodes in real life.

Circuit Diagrams

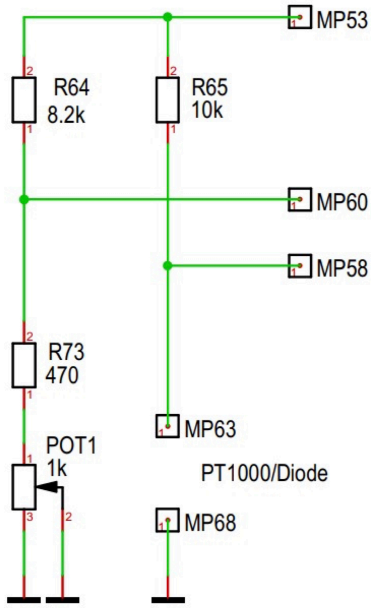

Figure 10: Schematic of the *bridge* circuit

Text Questions

(a) We measured 1078 Ω, that corresponds to 19.5 °C

(h) $V_{MP60} - V_{MP58} \approx -48.1$ mV

Original Turn-On Voltage: 0.612 V

New Turn-On Voltage $= 0.612\text{V} - 0.048\text{V} = \underline{0.564\text{V}}$

(i) 1270 Ω, corresponds to 67.5°C

(j) $\delta T = 67.5°C - 19.5°C = 48°C$, $\quad \frac{\delta V}{\delta T} = \frac{-0.048V}{48°C} = 1\frac{\text{mV}}{°\text{C}}$

Typical Literature Value is $\approx -2\frac{\text{mV}}{°\text{C}}$

Conclusion

We could see that the turn-on voltage shrinks considerably. We are not quite sure why our value is off by a factor 2 from the Literature value, maybe the diode was not as warm as the heating element.

1.5. Rectifier

1.5.1. Simulation

The goal was to simulate a full-wave rectifier with 1N4148 Si diodes.

Circuit Diagrams

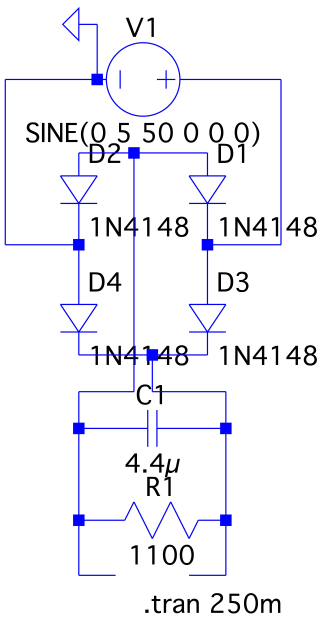

Figure 11: LTSpice circuit of full-wave rectifier

Plots

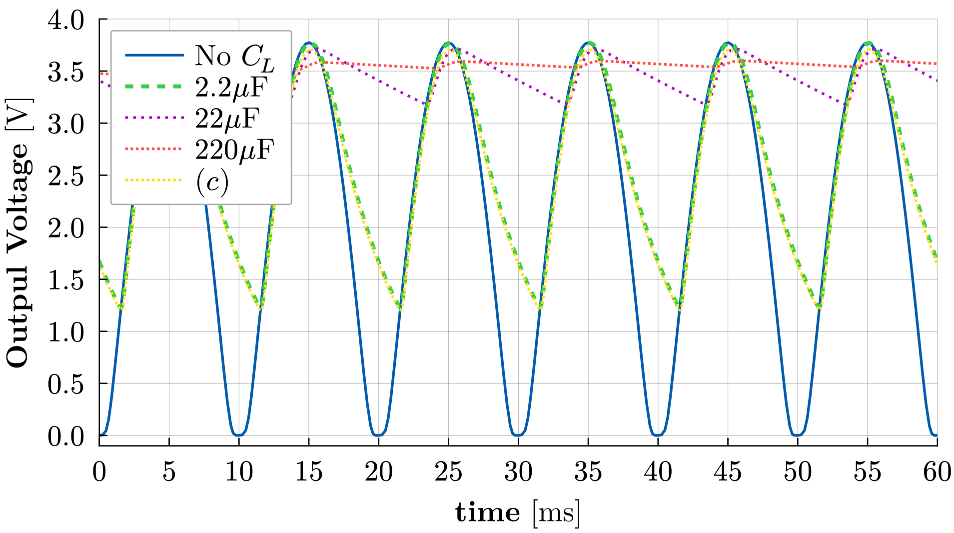

Figure 12: Full-wave rectifier output

Text Questions

(c) $C_L = 4.4\ \mu$F, $R_L = 1.1$ kΩ is almost the same output as $C_L = 2.2\ \mu$F, $R_L = 2.2$ kΩ as seen in Figure 12

(e) Hum Voltages:

- No $C_L \approx 3.7$ V
- 2.2μF ≈ 2.5 V
- 22μF ≈ 0.5 V
- 220μF ≈ 0.1 V

Conclusion

We clearly saw full waves being full waves being rectified and could see hum-voltages.

1.5.2. Measurement

The goal of the measurement was to measure the full-wave rectifier and its behaviour.

Circuit Diagrams

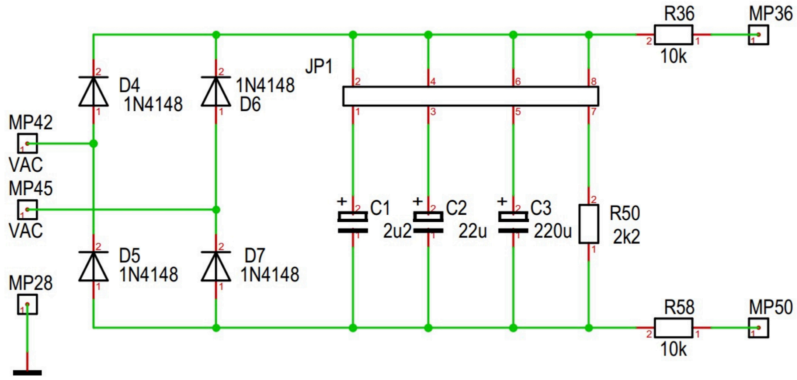

Figure 13: Schematic of the *rectifier* circuit

Plots

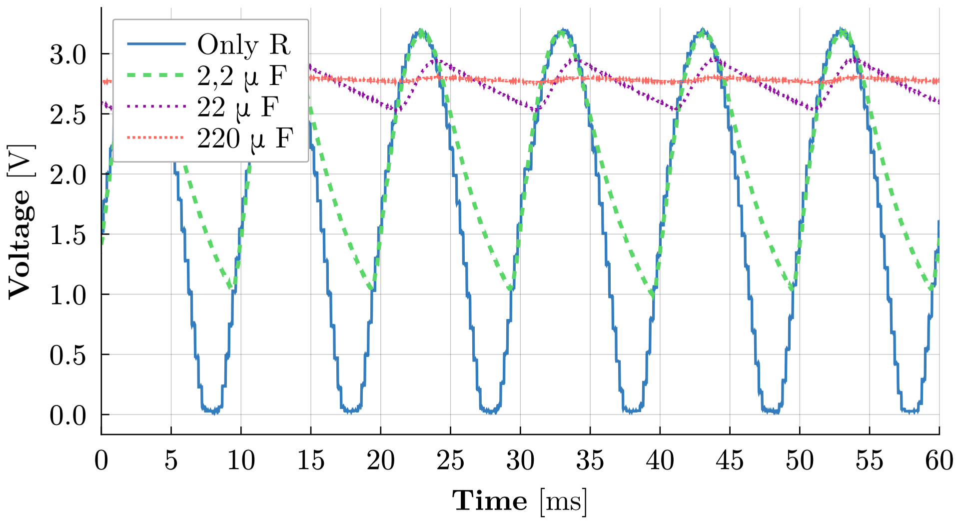

Figure 14: Measured Difference in Voltage

Text Questions

(g) Hum Voltages:

- Only R $\approx$ 3.2 V
- 2.2μF $\approx$ 2.2 V
- 22μF $\approx$ 0.45 V
- 220μF $\approx$ 0.05 V

Conclusion

The measured values and hum-voltages look a little chunky but really similar to the simulation. This is fun!