PHY405 Lab 7

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Collaborators for all questions: none. Partner (for Lab 1-10): Jacob Villasana.

R-1

Note: We had difficulty with out CW voltage multiplier (voltage was reduced in stage 1 instead of multiplied - TA had this problem with multiple groups; couldn't figure it out) and so our multiplier has 4 stages to ensure we could obtain an output over 20V.

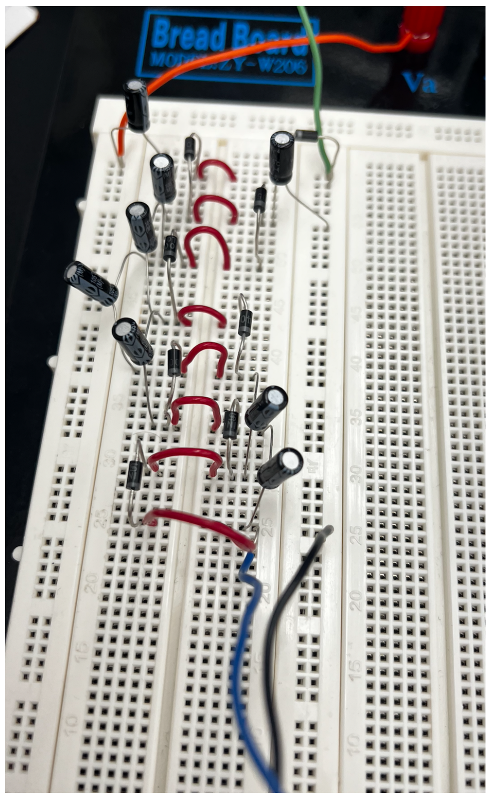

Figure 1: Cockroft-Walton 4-stage voltage multiplier build using rectifier diodes and 1μF capacitors. Voltage supply created by oscilloscope wavegen. Green wires are grounded, orange are voltage in, and red wires are internal connections.

R-2

Using the oscilloscope with a sine wave at 5-VPP, the output of our CW multiplier (also measured by the oscilloscope) was approximately 12.4 ± 0.1 V. At 10-VPP, we found the output to be 26.3 ± 0.1 V.

R-3

By adjusting the wavegen amplitude and measuring the bias voltage into the LED voltage divider, we found that pulses didn't start to form until $V_{\mathrm{DC}+} = 22 \pm 2$ V. The uncertainty is bigger because we had found that after multiple trials of trying to view pulses, there was a slight range of input voltage values ranging from 20-24 volts. Nice pulses were obtains with the amplitude fine knob.

R-4

Figure 2: (Left and right) oscilloscope screen captures of analog pulses created by the LED voltage divider at 9.4 and 9.3 VPP wavegen inputs, respectively. Pulses are faint, but they exist.

R-5

Using the Arduino analog input from the output of the voltage divider, the LED was left covered and uncovered for ~ 2 minutes each. The text from the IDE was copied and averaged using ChatGPT (I didn't want to copy each entry in - but we still have the data if you're curious about the analysis). When the LED was covered, the average pulses/second was 1.16. When it was uncovered, the average was 50.63 pulses/second.

R-6

Figure 3: Oscilloscope screen capture of analog (lower) and digital (upper) pulses created by the LED voltage divider before and after passing through the discriminator circuit.

Building the discriminator circuit on the back of the voltage multiplier and measuring the analog / digital inputs and outputs, respectively from the discriminator, each pulse was discretized.

The potentiometer was adjusted so that the height of the digital pulses was a maximum, and the waveforms were not inverted (upside-down).

R-7

Using the same method as in (R5) with the LED covered and uncovered, however this time measuring the digital pulses from the discriminator output, we found that covered yielded a pulse rate of 0.8 pulses/minute, and uncovered, 187.9 pulses/minute. The increase of this is probably because the discriminator amplifies disturbances of any size to 5V, and not just what the analog output feeds it.

R-8

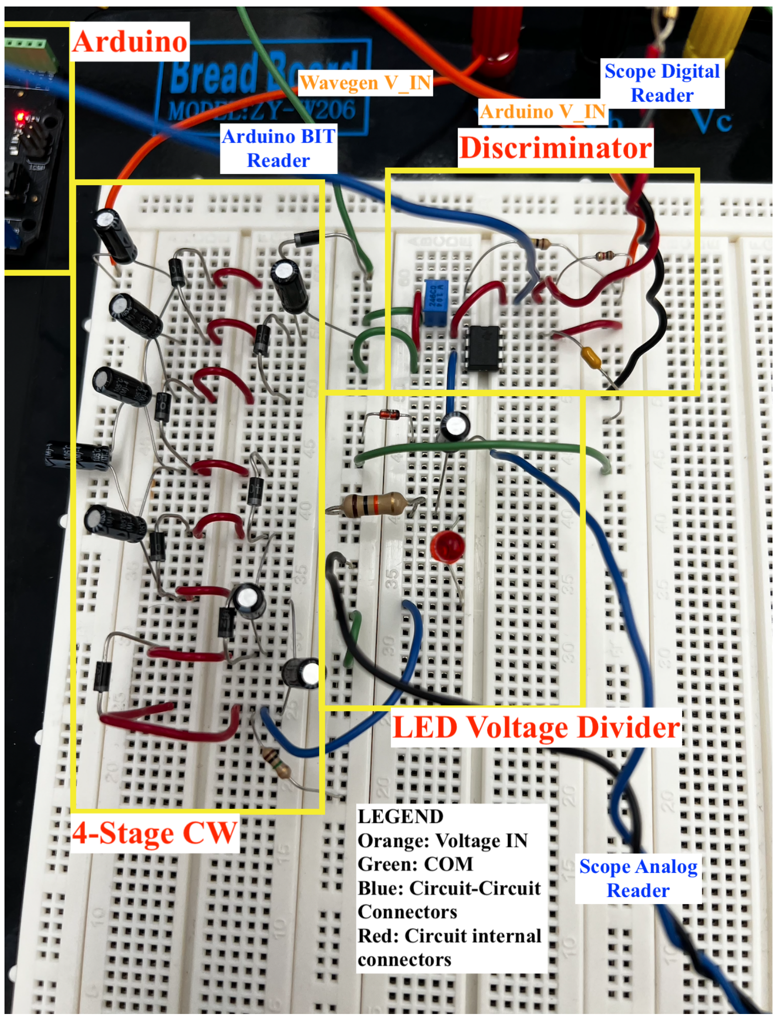

Figure 4: Image of final circuit design, including the CW multiplier (wavegen-powered), the LED voltage divider, and the discriminator circuit (Arduino-powered 5V). The oscilloscope inputs are inserted before and after the discriminator circuit to measure for R6/R7. Green wires are grounded. Orange wires are voltage sources. Blue wires are circuit-to-circuit connections. Red wires are internal circuit connections (since there's 3 circuits here). Black wires are used for Arduino/scope inputs.