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EEE419 Lab 3 Preliminary

Introduction:

The experiment consists of two separate parts. In the first part, a circuit will be designed to determine the storage time of a p-n junction diode, and lifetime of the carriers will be find. For the second part of the experiment, a circuit will be desinged which includes thyristor, OPAMP, and diode. The power dissipated on the load resistor R_L will be measured.

Methodology:

For the first part, the circuit in Fig. 1 is designed. A pulse generator is used to observe both forward and reverse bias behavior of the diode.

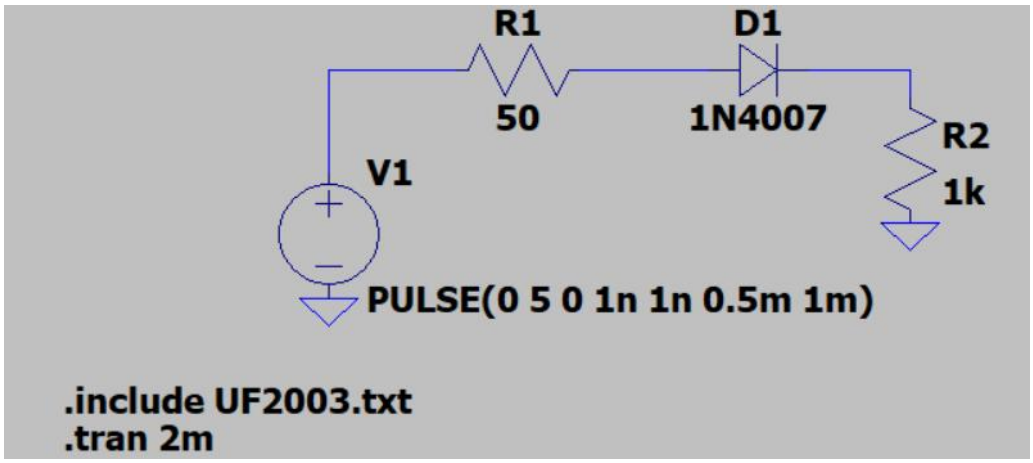

Fig. 1: Part 1 circuit schematic

For the second part, the following circuit is designed. The ratio of the potentiometer is adjusted so that the output of the OPAMP has a 3ms delay compared to the 36V rms 50Hz input voltage V_T. Also 36V rms is equal to 51V pk-pk.

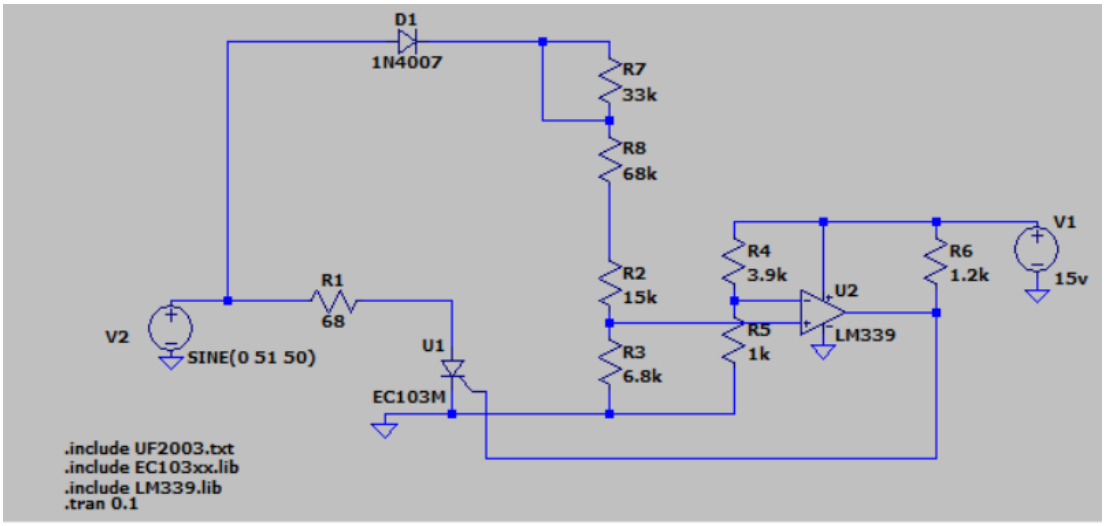

Fig. 2: Part 2 circuit schematic

Analysis:

Part 1: For finding the storage time, the current waveform of the diode will be observed. When diode is reverse biased, a negative peak current (spike) was observed. From that point to when current goes to 0A will be the storage time t_s.

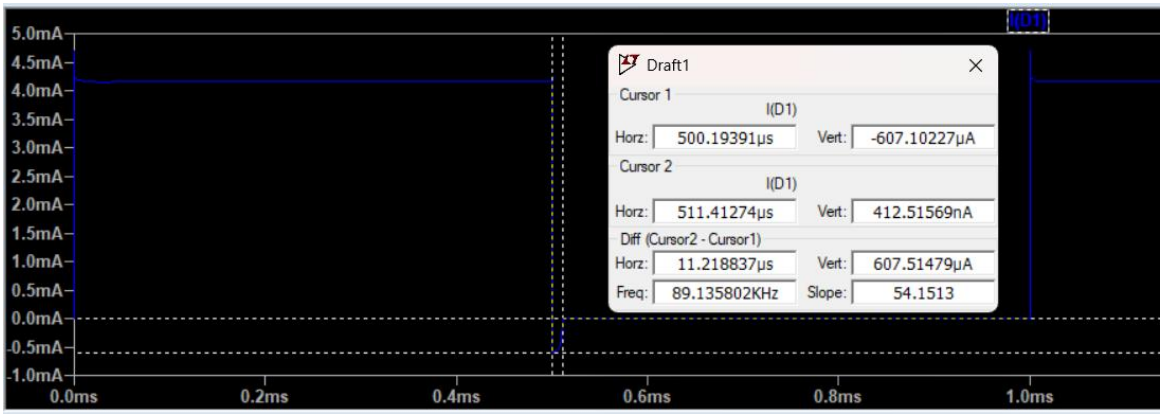

Fig. 3: Diode current waveform (1N4007)

As seen from above figure, the storage time t_s is measured as 11.22µs for 1N4007 diode.

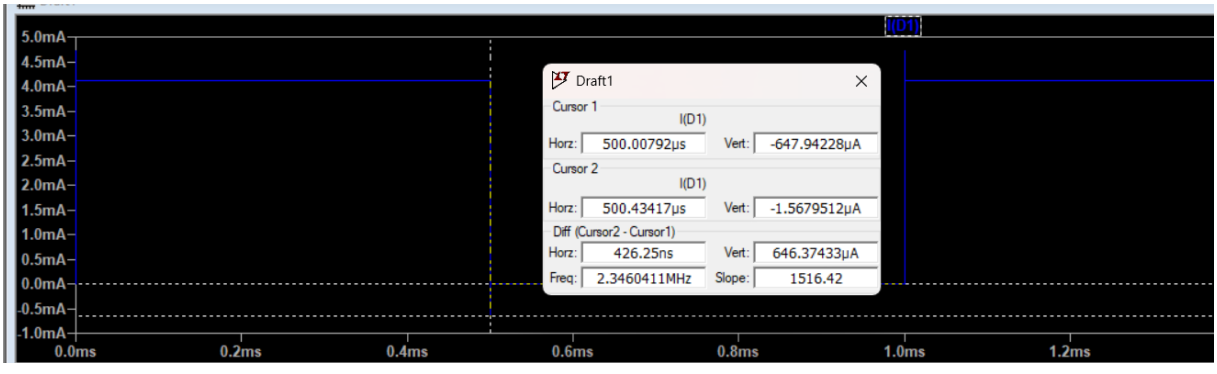

Fig. 4: Diode current waveform (UF2003)

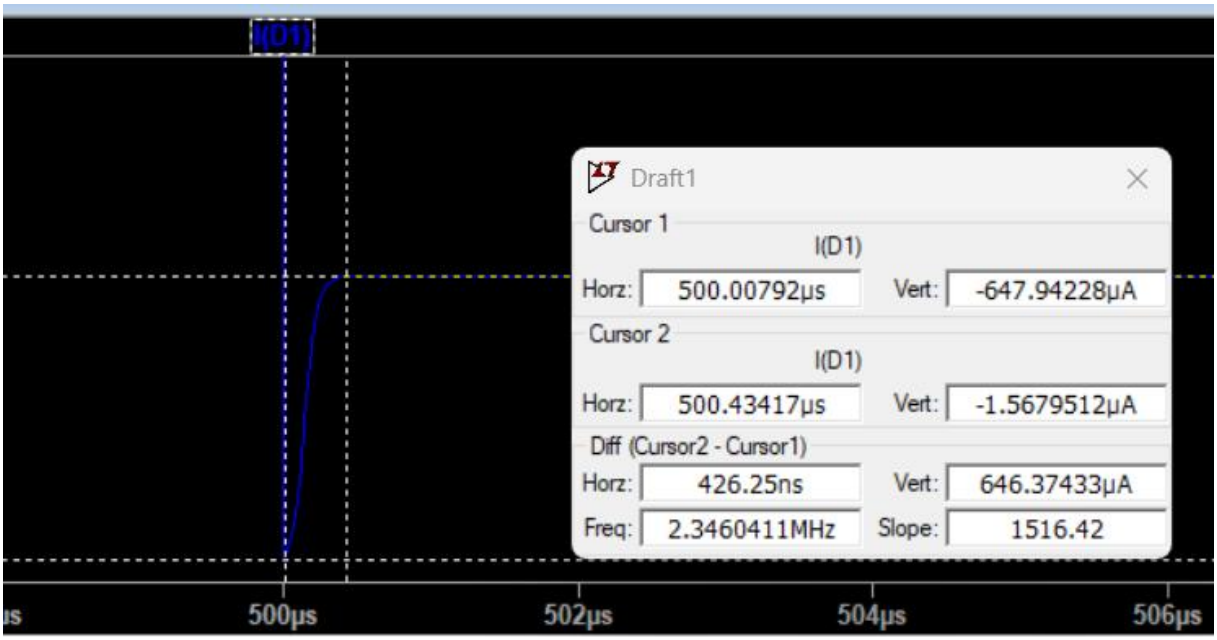

Fig. 5: Zoomed in version (UF2003)

For UF2003 diode, the storage time is measured as 426.25ns. Because UF2003 is a ultra fast recitifier, the storage time is much less than 1N4007 diode.

For finding the lifetime of the carriers τ_p, the formula is given below:

$$\tau_p = \frac{t_s}{\ln(1 + {}^{I_R}/_{I_F})}$$

$$I_R : peak\ reverse\ current$$

$$I_F : Forward\ bias\ current$$

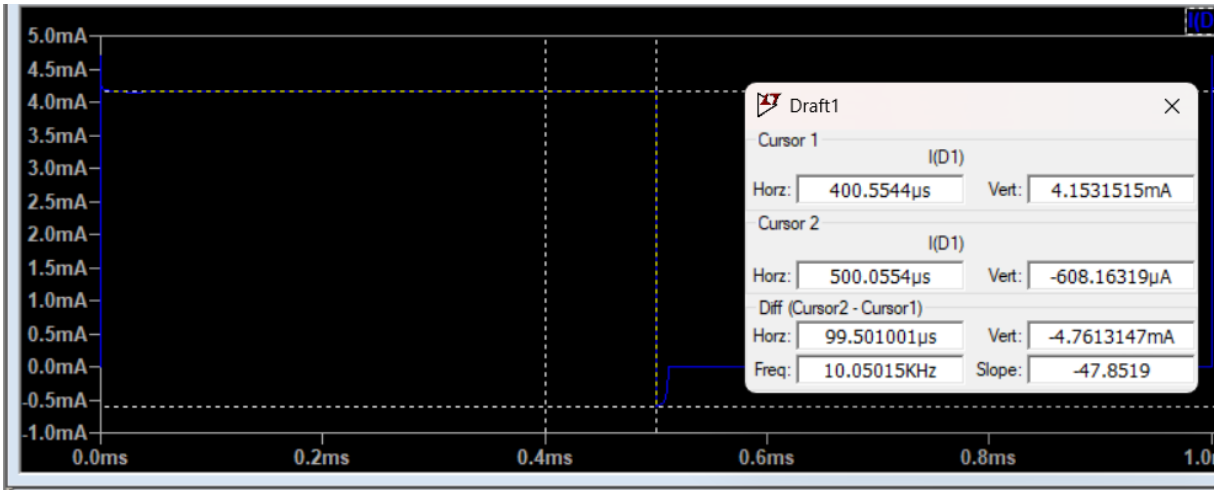

Fig. 6: Values for 1N4007 diode

In Fig. 6, cursor 1 shows the forward bias current (I_F), and cursor 2 shows the reverse bias peak current (I_R). Putting these value in the formula will give the following value for lifetime carriers of 1N4007 diode.

$$\tau_p = 82\mu s$$

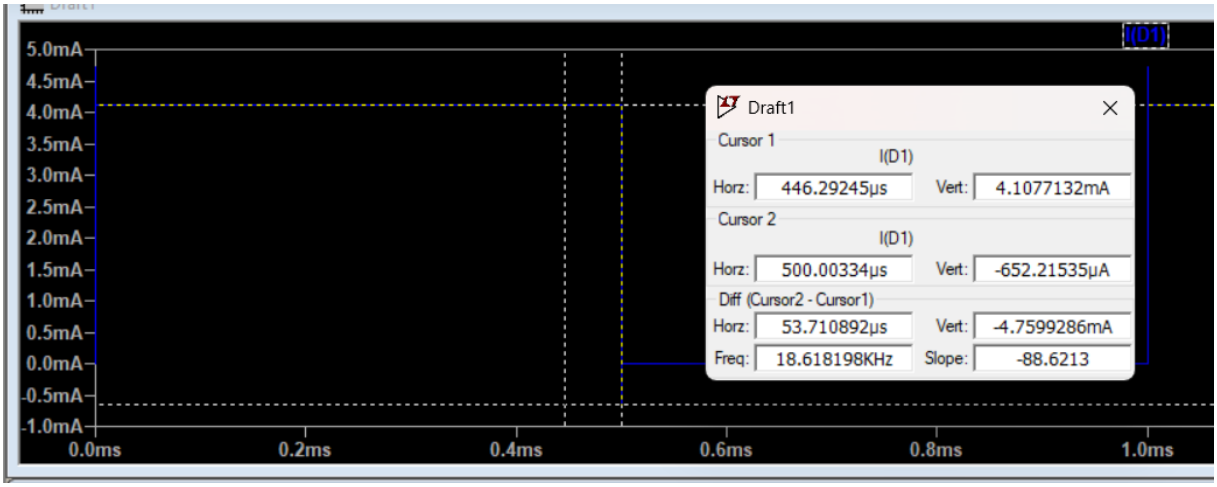

Fig. 7: Values for UF2003 diode

In Fig. 7, cursor 1 shows the forward bias current (I_F), and cursor 2 shows the reverse bias peak current (I_R) for UF2003 diode. With measured values, the lifetime of the carriers for UF2003 diode is calculated as follows:

$$\tau_p = 29\mu s$$

Part 2:

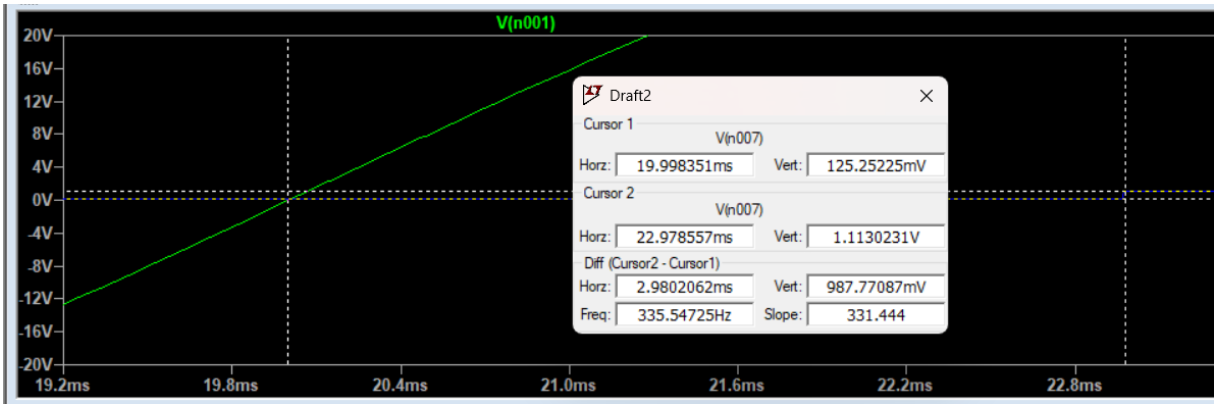

Fig. 8: OPAMP output 3ms delay

As seen from Fig. 8, the delay between zero of the input voltage V_T and output of the OPAMP is very close to 3ms.

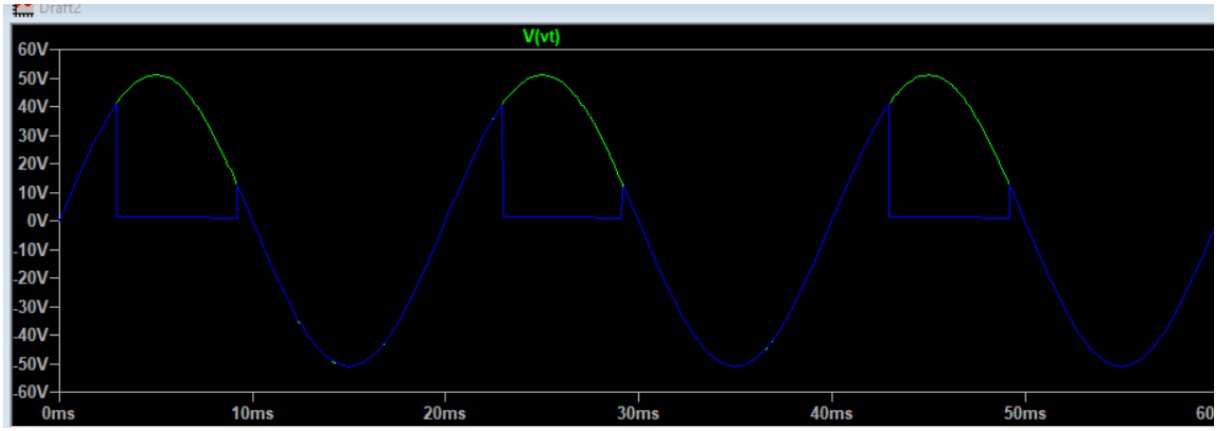

Fig. 9: V_T and V_A voltages

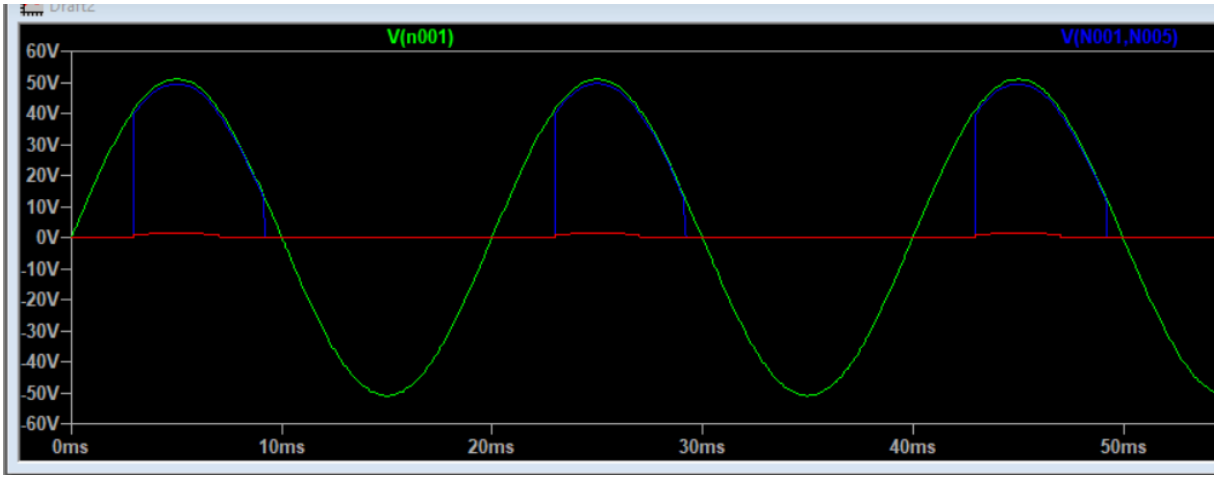

Fig. 10: Thyristor waveform

In Fig. 10, green curve (V_T) is 36V rms 50Hz input signal. Blue curve (V_T-V_A) is the voltage across the load resistor R_L, and red line is the voltage waveform of the output of the OPAMP (gate of the thyristor). As seen, when red line has a rising edge, the thyristor turns ON, and when the gate voltage has a falling edge, thyristor turns OFF.

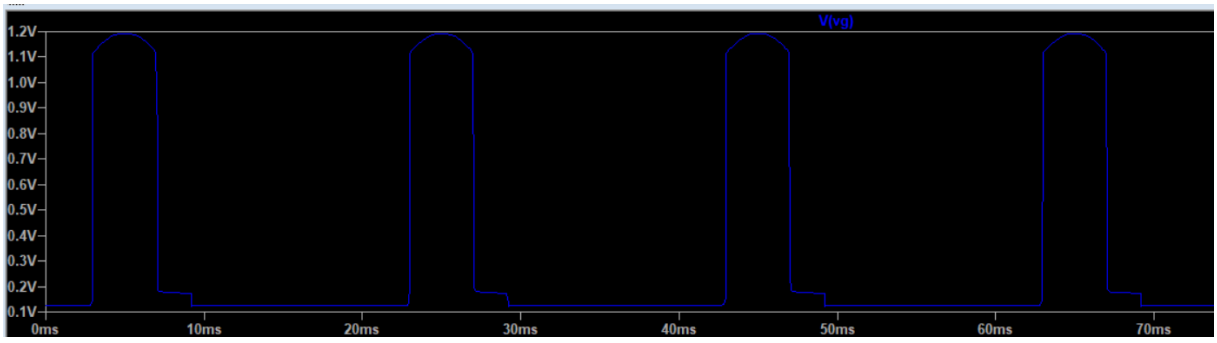

Fig. 11: Gate voltage of the thyristor

As seen from Fig. 11, while conducting, the gate voltage of the thyristor is around 1.2V, and the shape of the waveform resembles to pulse.

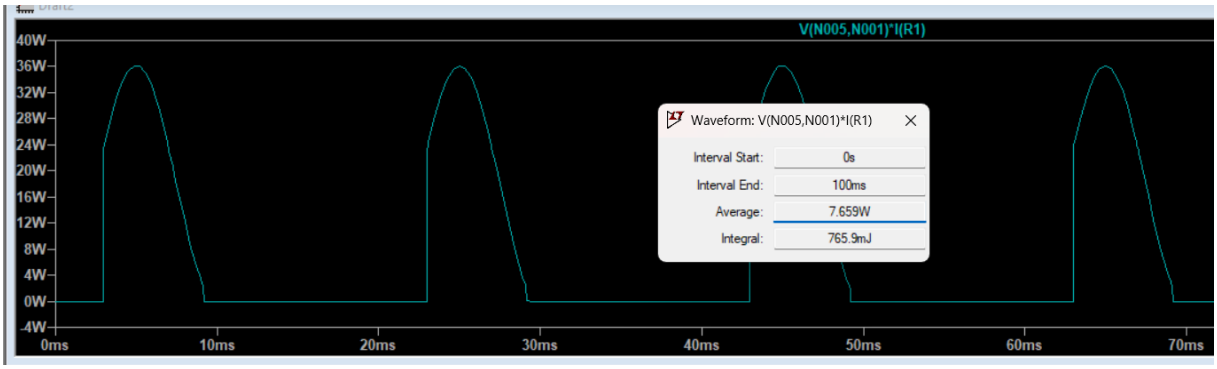

Fig. 12: Power dissipated at R_L

The power dissipated at the load resistor R_L is measured as 7.66W when there is an integer number of cycles on the window.

Table 1: Power values with respect to trimpot values

Trimpot Value	Power
10K	8.9W
20K	8.87W
30K	8.83W
40K	8.77W
50K	8.68W
60K	8.57W
70K	8.42W
80K	8.23W
90K	7.98W
100K	7.66W