VE311 Lab 1

Weikai Zhou 518021911039

1. Voltage Regulator

(a) In this part, we first build the circuit below (Figure 1) in Proteus, where $R_1 = 5\ \text{k}\Omega$, $V_s = 10$ V. The simulation result is also in the figure.

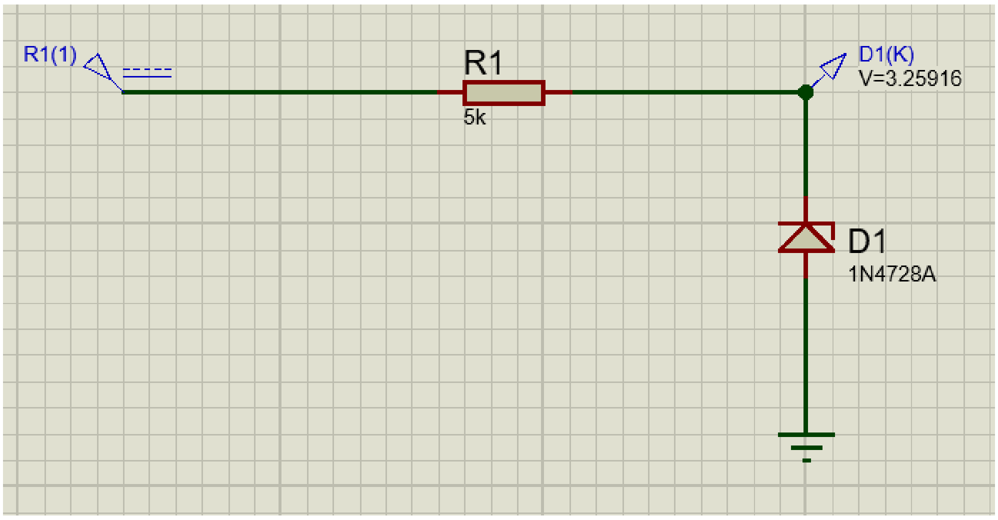

Figure 1. Proteus circuit and simulation result

When doing the lab, the measurement result is shown below (Figure 2).

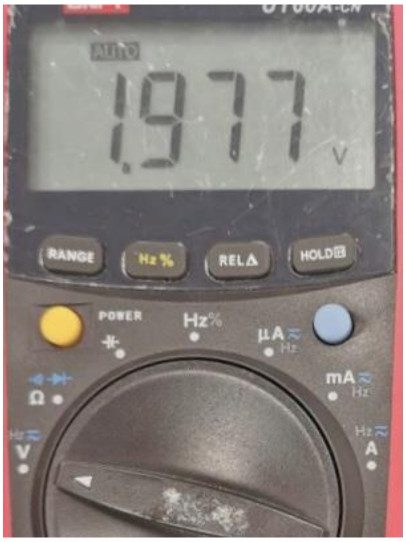

Figure 2. Measurement

From the figure, we know the measurement result is 1.977 V, but the diode we used is different from manual. Considering the diode in manual, the typical $V_z = 10\Omega$, and theoretically, the voltage should be

$$\frac{(10-3.3)\times 30}{30+5000} + 3.3 = 3.340\ V,$$

and our simulation result is close to this value.

(b) In this part, we first build the circuit below (Figure 3) in Proteus, where $R_1 = 5\ \mathrm{k}\Omega$, $V_s = 10 + 1\sin(2\pi 60 \cdot \mathrm{time})$ V. The simulation result is in Figure 4.

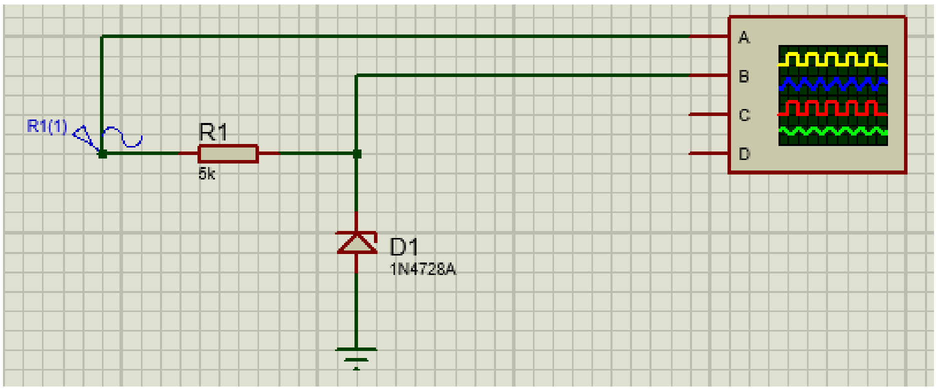

Figure 3. Proteus circuit

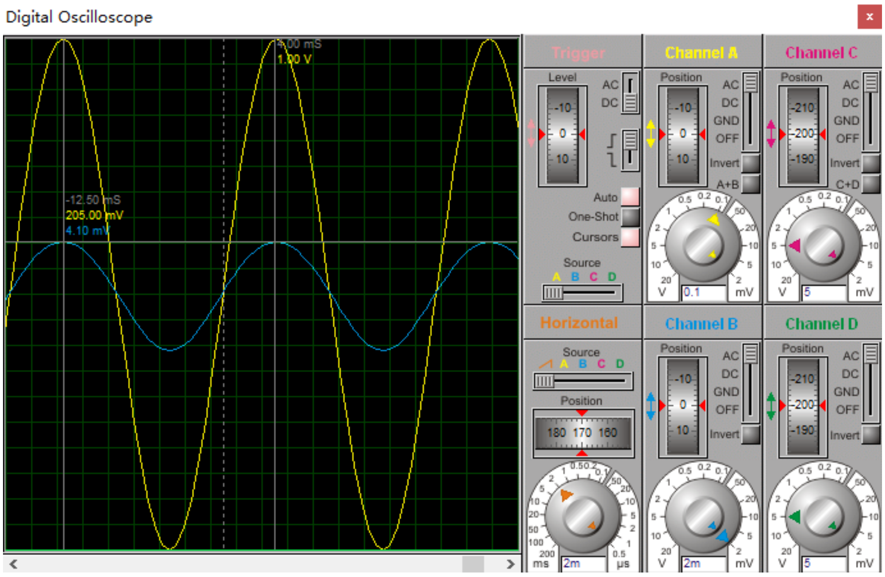

Figure 4. Simulation result

From the cursors of the simulation result, we can have that the line regulation is

$$\frac{4.1 \times 10^{-3}}{1.00} = 4.1 \times 10^{-3}.$$

By using the equation that

$$\text{line regulation} = \frac{R_z}{R + R_z},$$

we can get that $R_z = 20.58\ \Omega$.

In lab, we get the following waveform (Figure 5), which is similar to the simulation waveform.

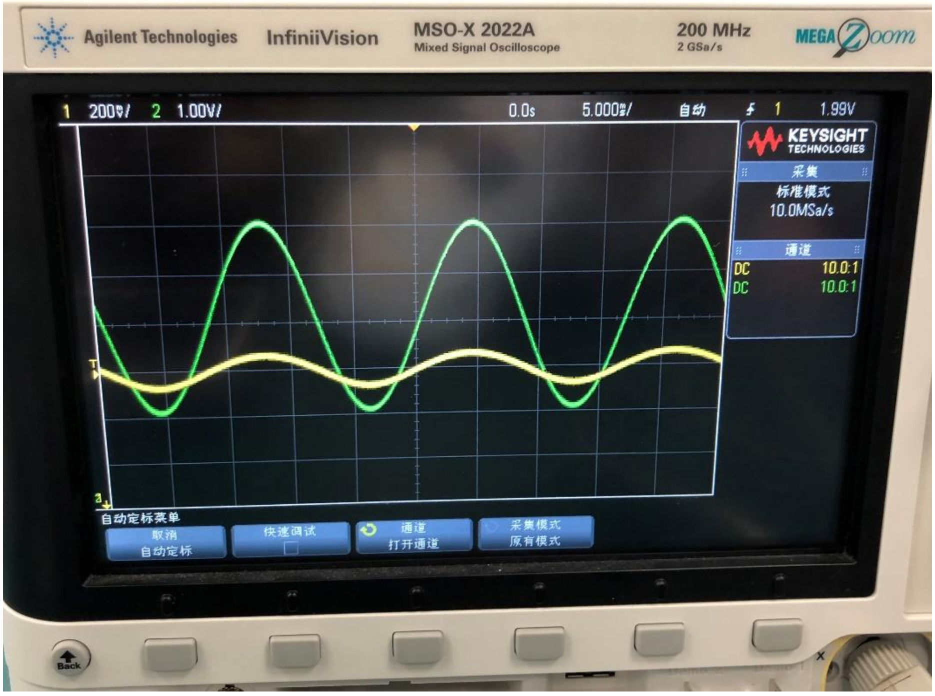

Figure 5. Waveform

If $V_s = 2 + 3\sin(2\pi 60 \cdot \text{time})$ V, we will get the following result (Figure 6).

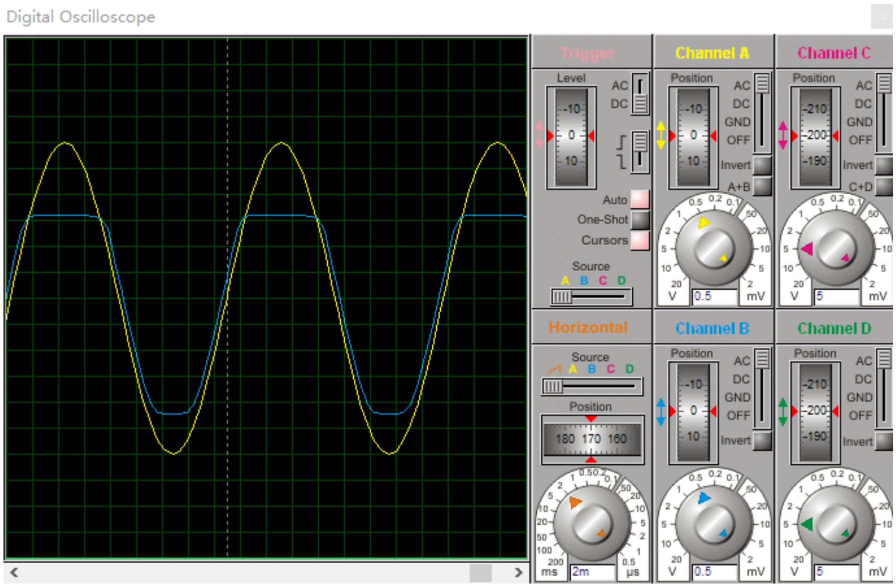

Figure 6. Simulation result

When the voltage is higher than V_z, the V_L is almost the same as V_z. When the voltage is lower than V_z, the V_L is the same as V_s.

(c) In this part, we first build the circuit below (Figure 7) in Proteus, where $R_1 = 5\ \mathrm{k}\Omega$, $V_s = 10$ V.

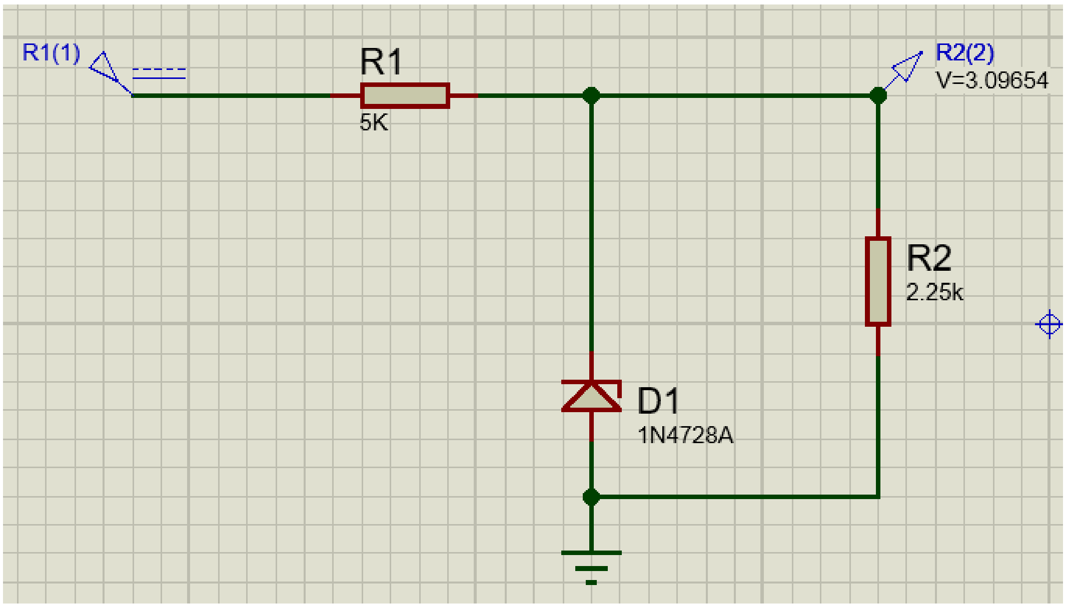

Figure 7. Simulation result

From the figure, we can know that $R_{L,min} = 2.25\ \mathrm{k}\Omega$. If we continue decrease R_L, the voltage regulator stops working.

In lab, we get the following result (Figure 8).

Figure 8. Lab result

If we want to make $R_{L,min}$ becomes 10 times smaller, we can decrease R to be 10 times smaller.

2. Half-Wave Rectifier

In this part, we first using the following equation to get the value of C.

$$V_r = (V_s - V_{on})\frac{T}{RC} < 0.1 \quad => \quad C = 3.67 \times 10^{-5}\ \mathrm{F}.$$

Then, we can get the following Proteus circuit (Figure 9).

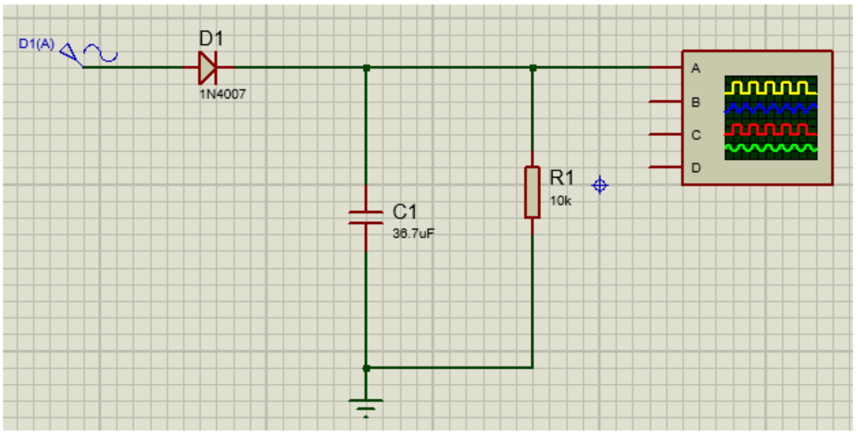

Figure 9. Proteus circuit

And we can get the following simulation result (Figure 10).

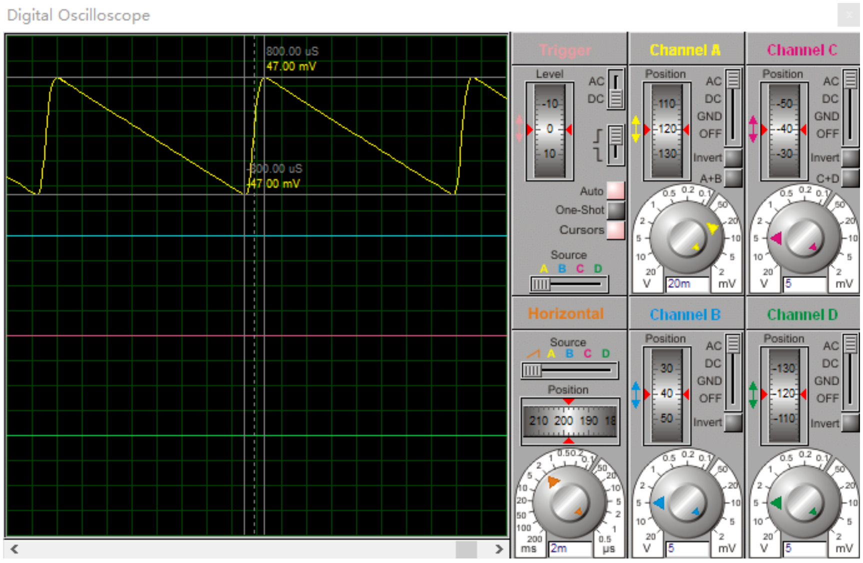

Figure 10. Simulation result

We can check that $V_r = 0.094$ V, satisfying our goal.
Besides, we can have the following

$$V_{dc} = V_s - V_{on} = 3 - 0.8 = 2.2\ \mathrm{V}$$

$$I_{dc} = \frac{V_{dc}}{R} = \frac{2.2}{10\ \mathrm{k}} = 2.2 \times 10^{-4}\ \mathrm{A}$$

$$\theta_c = \sqrt{\frac{2V_r}{V_s}} = \sqrt{\frac{2 \times 0.1}{3}} = 0.258\ \mathrm{rad}$$

$$\Delta T = \frac{1}{\omega}\sqrt{\frac{2V_r}{V_s}} = \frac{1}{2\pi 60}\sqrt{\frac{2 \times 0.1}{3}} = 6.85 \times 10^{-4}\ \mathrm{s}$$

$$I_{peak} = \frac{2I_{dc}T}{\Delta T} = \frac{2 \times 2.2 \times 10^{-4} \times \frac{1}{60}}{6.85 \times 10^{-4}} = 0.0107\ \mathrm{A}$$

$$I_{surge} = \omega C V_s = 2\pi 60 \times 3.67 \times 10^{-5} \times 3 = 0.0415\ \mathrm{A}$$

$$PIV = 2V_s - V_{on} = 2 \times 3 - 0.8 = 5.2\ \mathrm{V}$$

If $V_s = 3\sin(2\pi 30 \cdot \mathrm{time})$, we can know that V_r may become 2 times of the original value from the equation $V_r = (V_s - V_{on})\frac{T}{RC}$.

In lab, we have the following wave form (Figure 11).

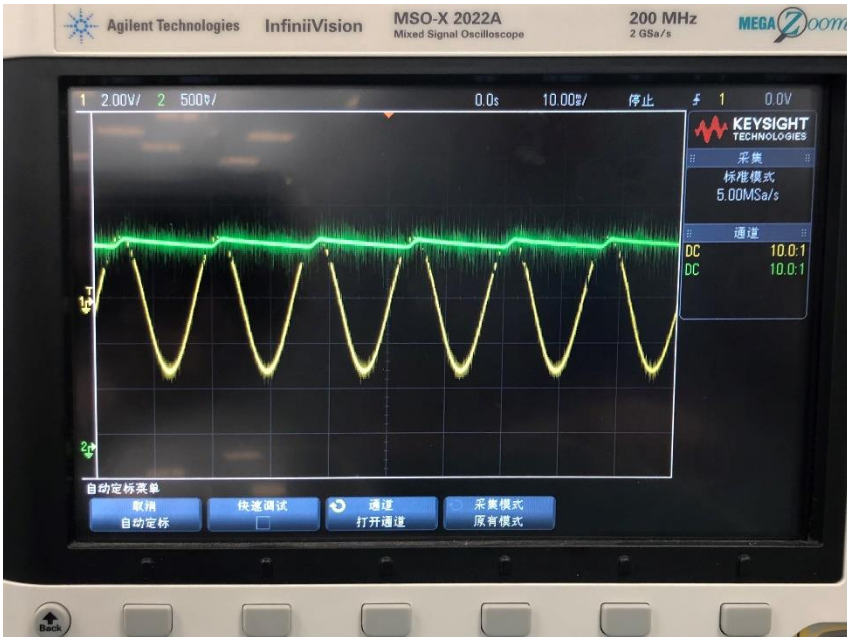

Figure 11. Wave form