Further OrCAD

Team	Autumn, 2022
Module	**EE1616 Electronics Workshop**
Class	34092102
Brunel ID	2161047
CQUPT ID	2021215069
Name	Xukang Liu
Tutor	Zhipeng Wang

Introduction and aims:

To further understanding the use of the software. To provide understanding of some characteristic of components. In addition, be familiar with capacitors, inductors, resistances and diodes. Measure the current of these components and describe the characteristics.

Task description:

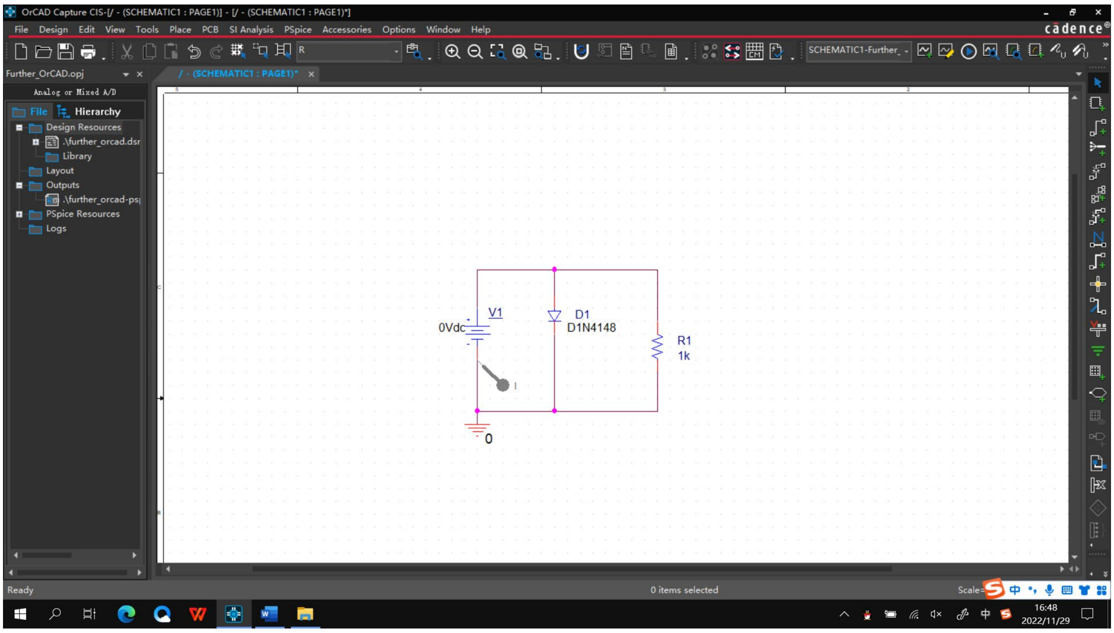
1. Familiar with the theory which we learned before. Further understanding the linear and non-linear components.
2. Use DC source to create circuit diagrams. Let DC source as a variable. Show the current against voltage diagram.
3. Use AC source to create circuit diagrams. Let AC source frequency as a variable. Show the current against frequency diagram.

Experiment method:

1. Review the characteristics and the theorems of diodes, capacitors and inductors.
2. Simulate the 6 circuit diagrams. Explain the reasons for the simulation results.

Result and observations:

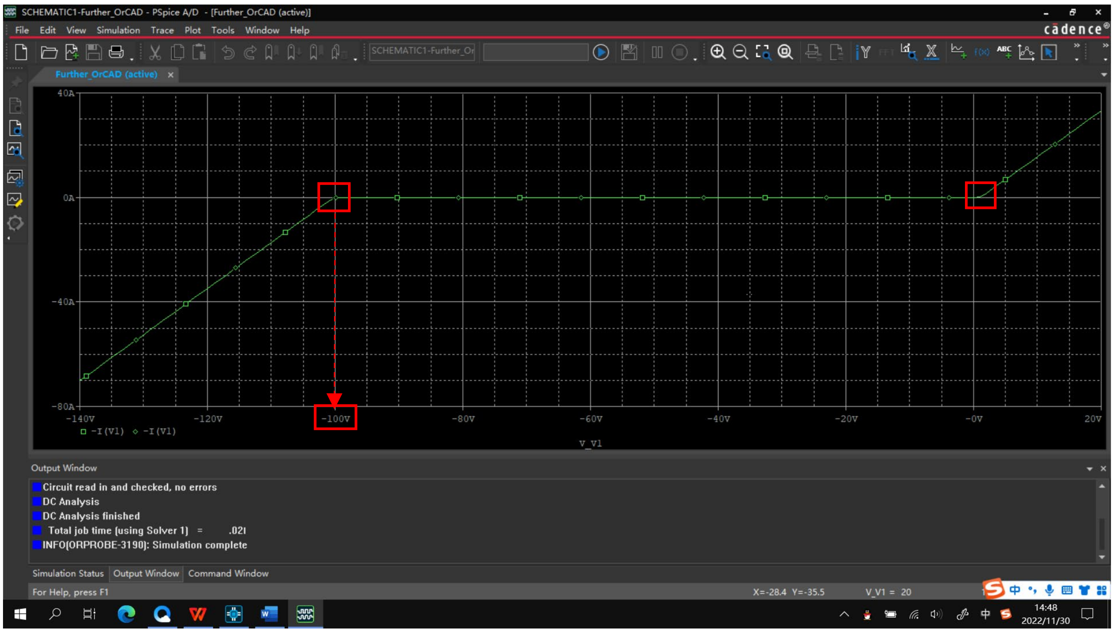
1.



This is the circuit diagram of DC source. The diode is parallel with resistance.

Parameter 参数	Test condition 测试条件	Part	Symbol 符号	最小	最大	Unit 单位
Forward voltage 正向电压（压降）	IF = 5 mA	1N4448-TR	VF	0.62	0.72	V
	IF = 10 mA	1N4148-TR	VF		1	V
	IF = 100 mA	1N4448-TR	VF		1	V
Reverse current 反向电流	VR = 20 V		IR		25	nA
	VR = 20 V, Tj = 150 ℃		IR		50	μA
	VR = 75 V		IR		5	μA
Breakdown voltage 击穿电压	IR = 100 μA, tp/T = 0.01, tp = 0.3 ms		V(BR)	100		V
Diode capacitance 极						

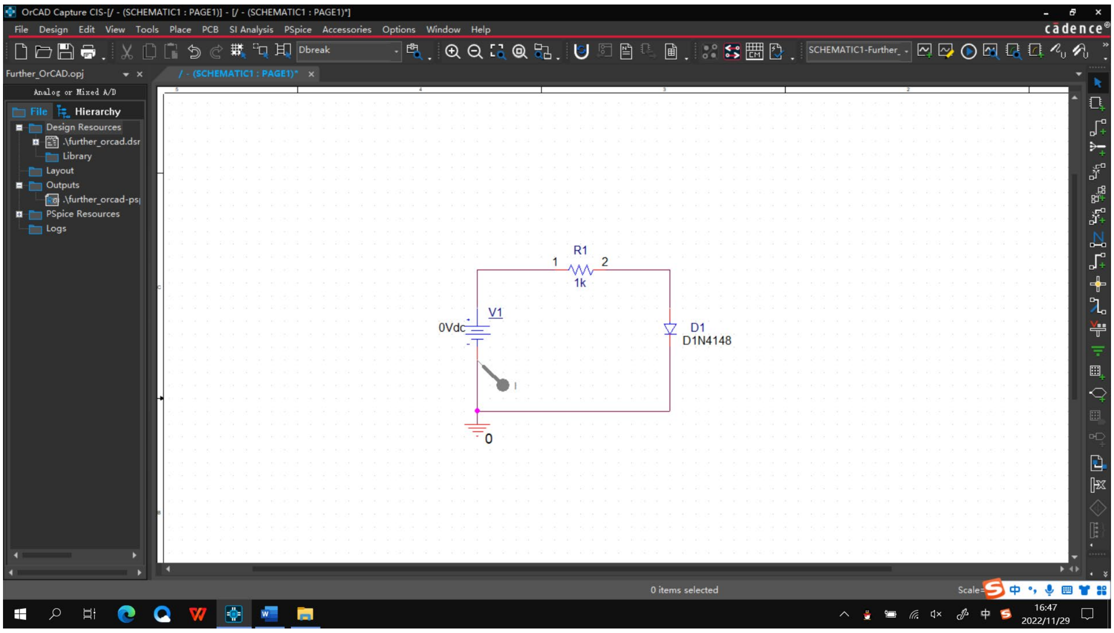
This is the parameter of the N1N4148 diode. According to the data, the **forward voltage** is exceedingly small, and the **breakdown voltage is -100V**. Next, I simulate it and evaluate the data.



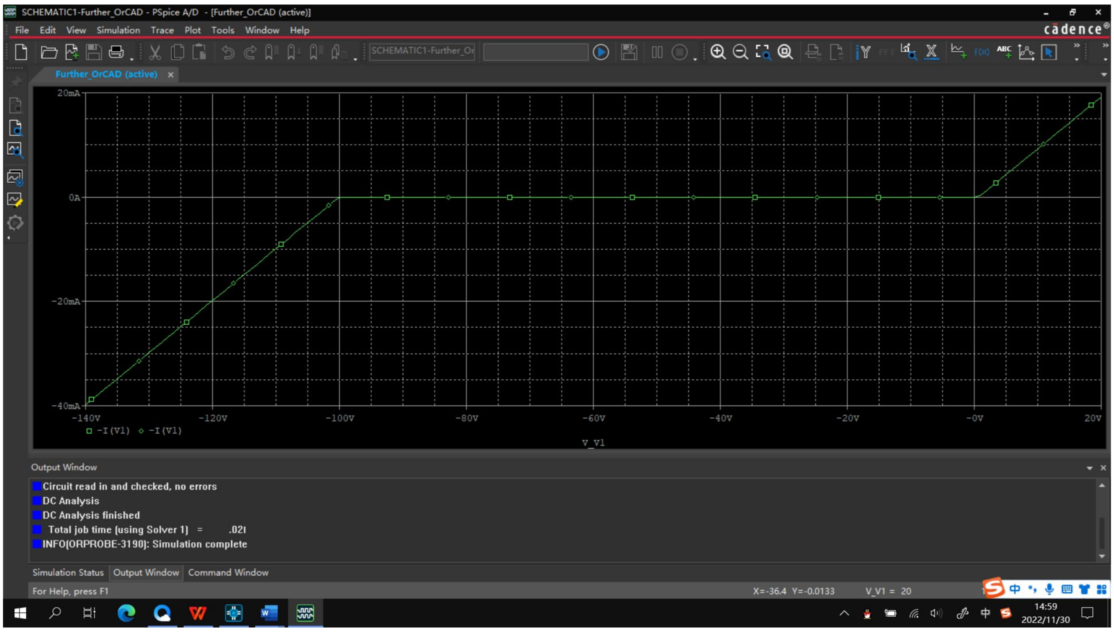
According to the simulate result. I can find that the characteristic of the diode and verify the data is correct. Each diode has forward voltage and breakdown voltage, but the breakdown voltage is much bigger than forward voltage.

Thus, we often say that the diode is conducting in forward direction and closing in reverse direction.

2.

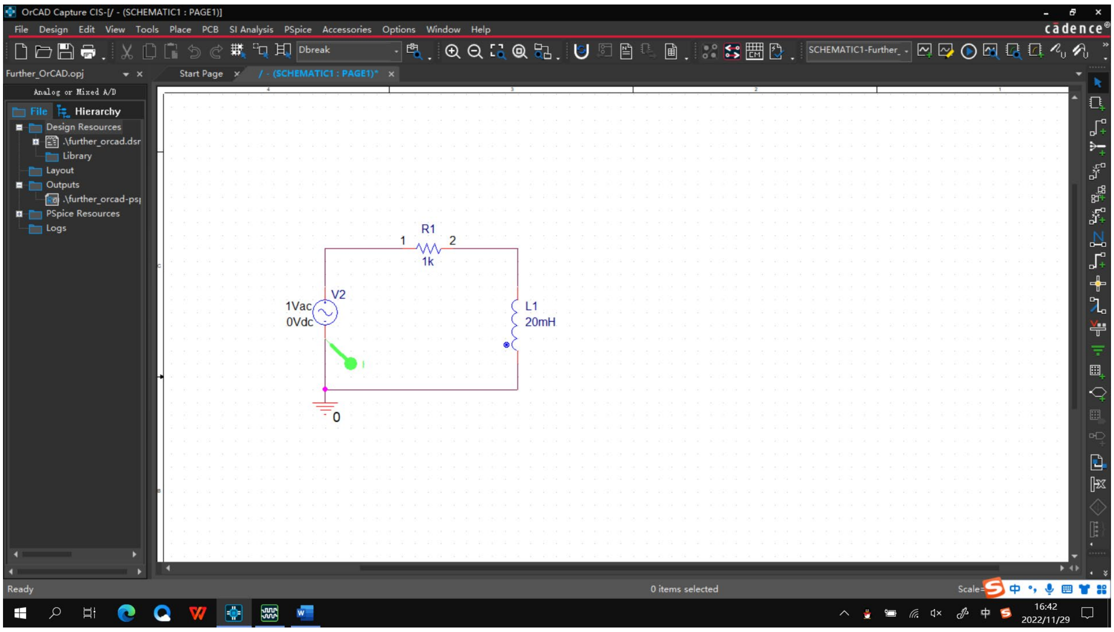


This is the circuit diagram of DC source. The diode is series with resistance.

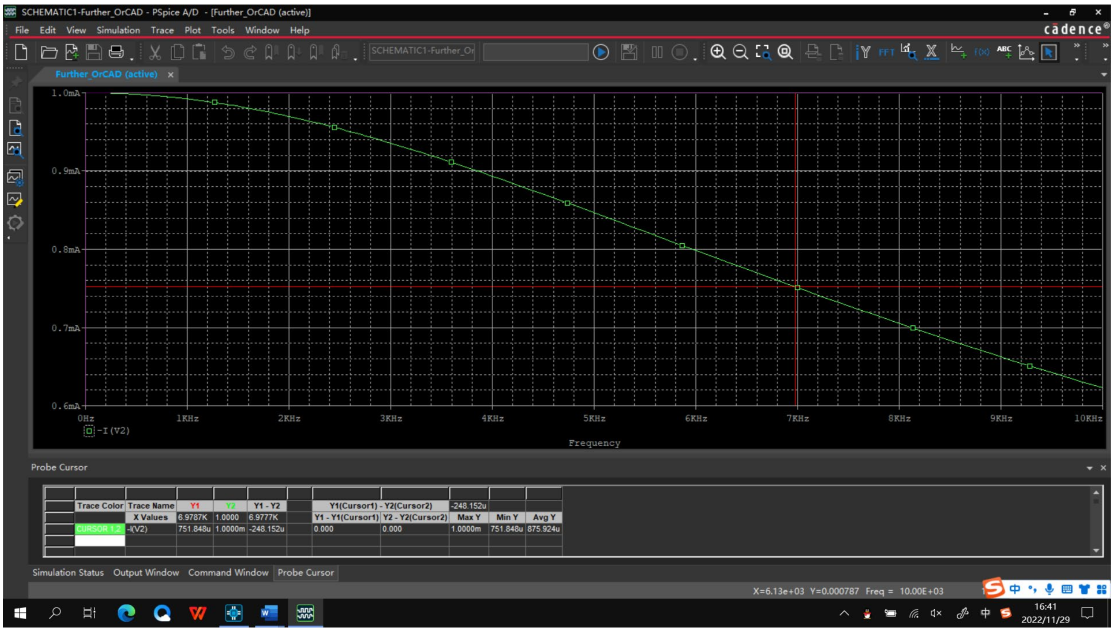


This is the simulate result. The shape of the curve is same as the first result. But the current is exceedingly small, it is milliamps(mA). The reason is the resistance is series with diode, $I = \frac{V}{R}$. R is very high ($k\Omega$). Thus, current is exceedingly small.

3.



This is circuit diagram of AC source. The inductance is series with resistance.



Firstly, I calculate the current by the theory.

$$I = \frac{V}{Z_T} = \frac{V}{X_L + R} = \frac{V}{R + j\omega L} = \frac{V}{\sqrt{R^2 + \omega^2 L^2}}$$

The independent variable is **frequency *f***.

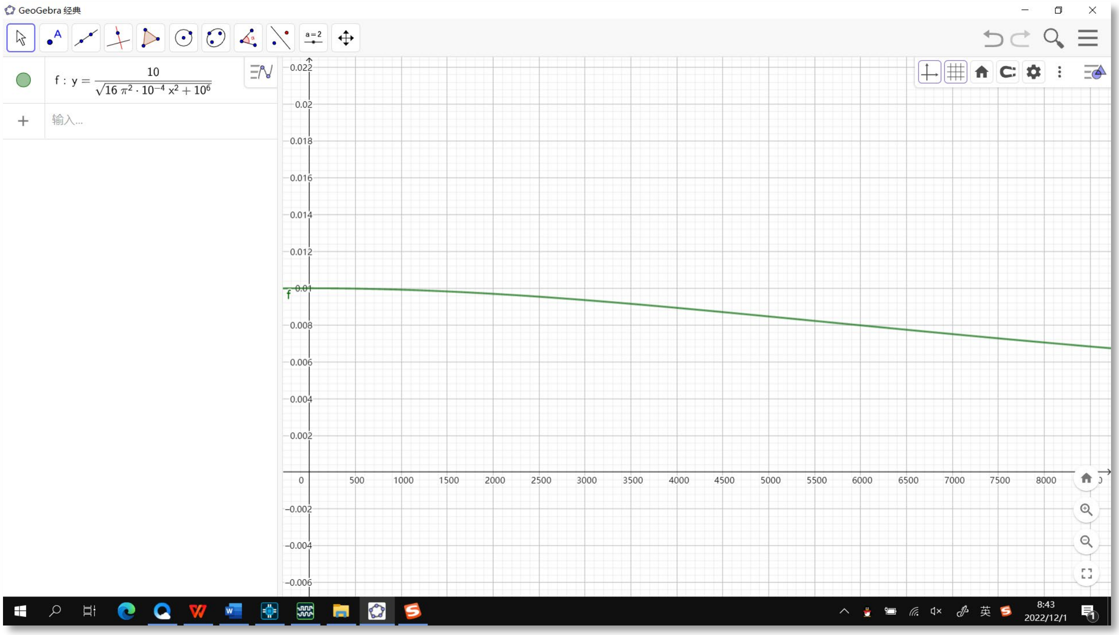
$$\omega = 2\pi f$$

In this circuit, $\boldsymbol{V = 10v, R = 1k\Omega, L = 20mH}$.

Thus, the calculation formula is

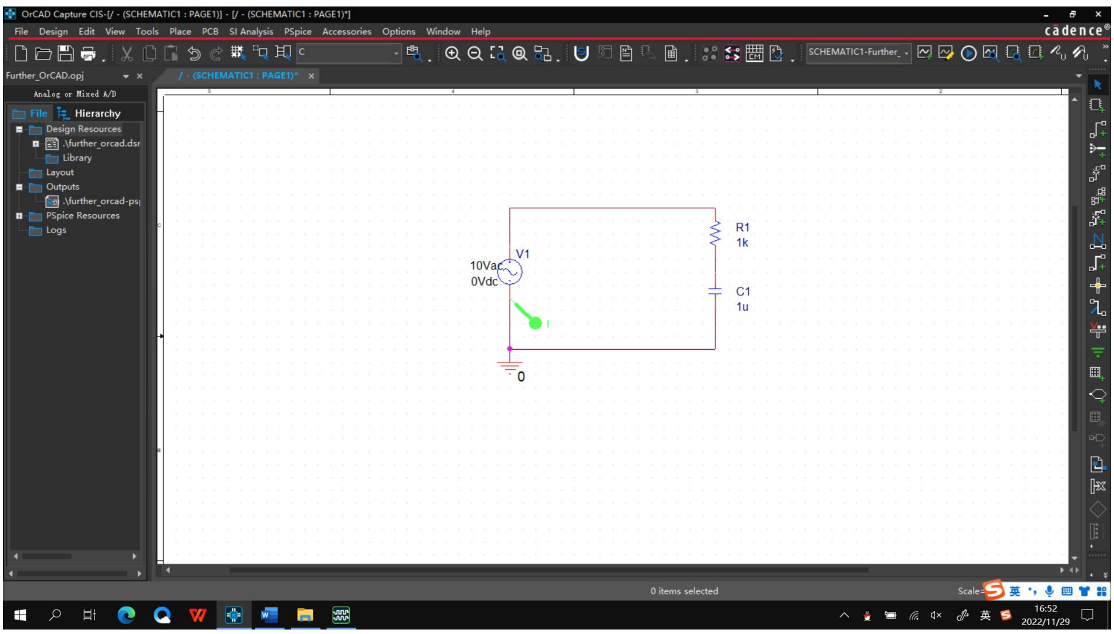
$$\boldsymbol{I} = \frac{10}{\sqrt{16 \times \pi^2 \times 10^{-4} \times f^2 + 1000^2}}$$

Simulate formulas using drawing software.

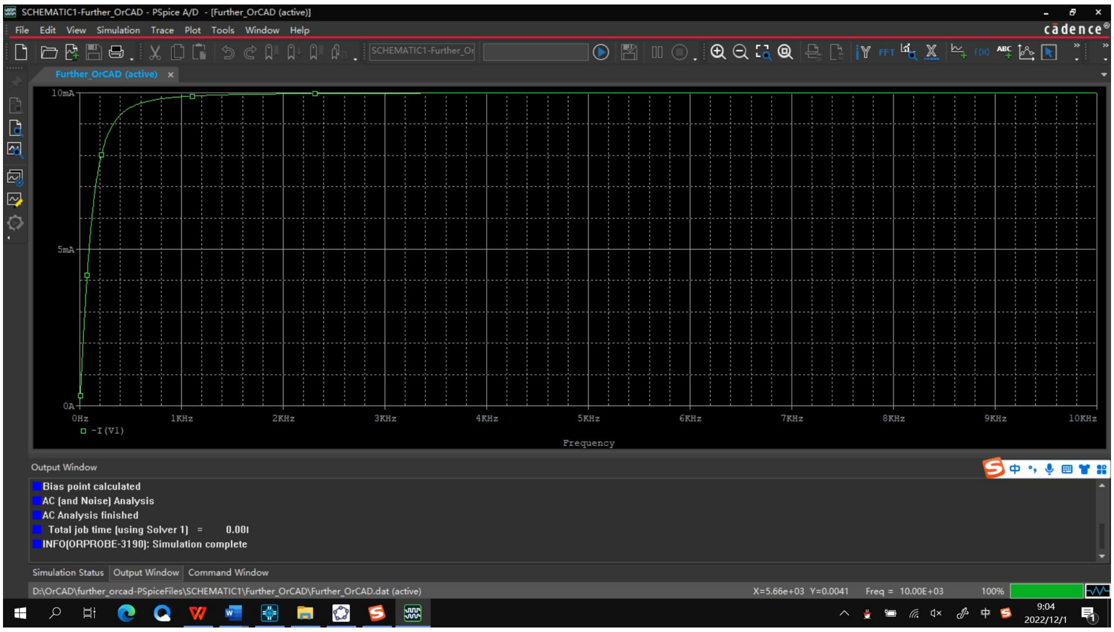


Thus, I can find that the formula graph is the same as the circuit simulate result.

4.



This is circuit diagram of AC source. The capacitor is series with resistance.



Before I enter **X-axis log button**, this is the simulate result.

According to the formula:

$$\boldsymbol{I} = \frac{V}{Z_T} = \frac{V}{X_C + R} = \frac{V}{R - j\dfrac{1}{\omega C}} = \frac{V}{\sqrt{R^2 + \dfrac{1}{(\omega C)^2}}}$$

The independent variable is **frequency** $\boldsymbol{f}$.

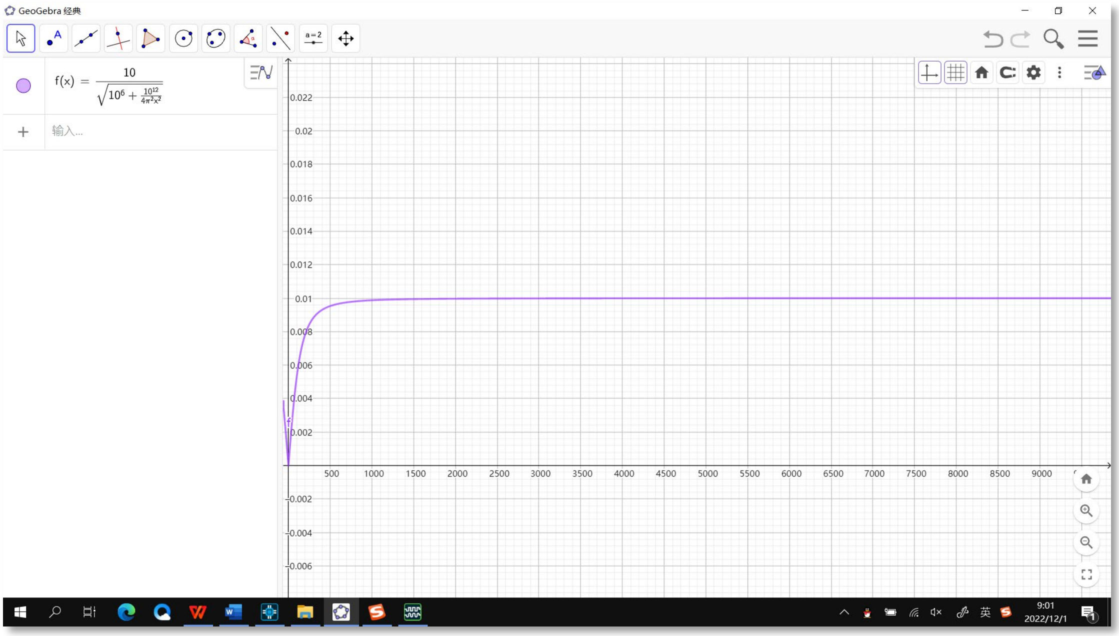
$$\omega = 2\pi f$$

In this circuit, $\boldsymbol{V = 10v, R = 1k\Omega, C = 1uF}$.

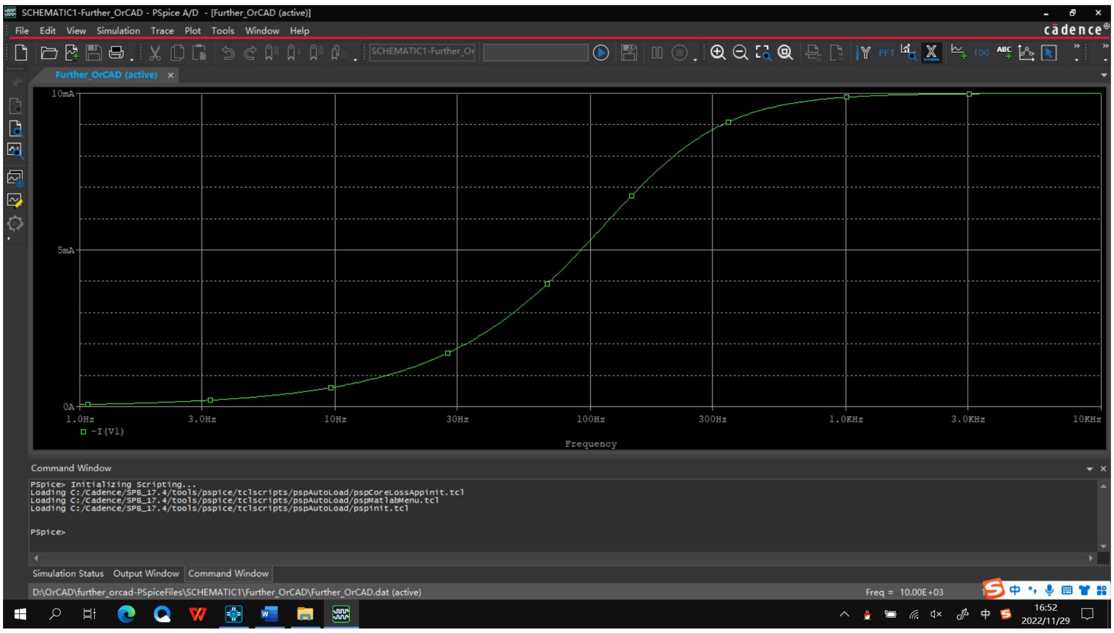
Thus, the calculation formula is

$$I = \frac{10}{\sqrt{\frac{10^{12}}{4\pi^2 \times f^2} + 1000^2}}$$

Simulate formulas using drawing software.

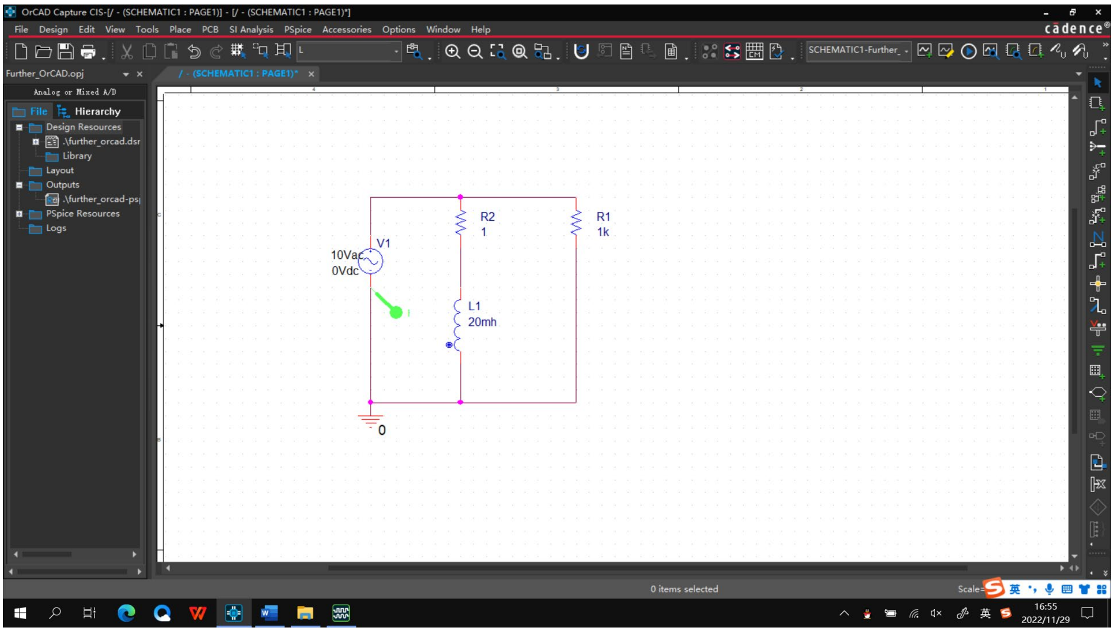


Thus, I can find that the formula graph is the same as the circuit simulate result.

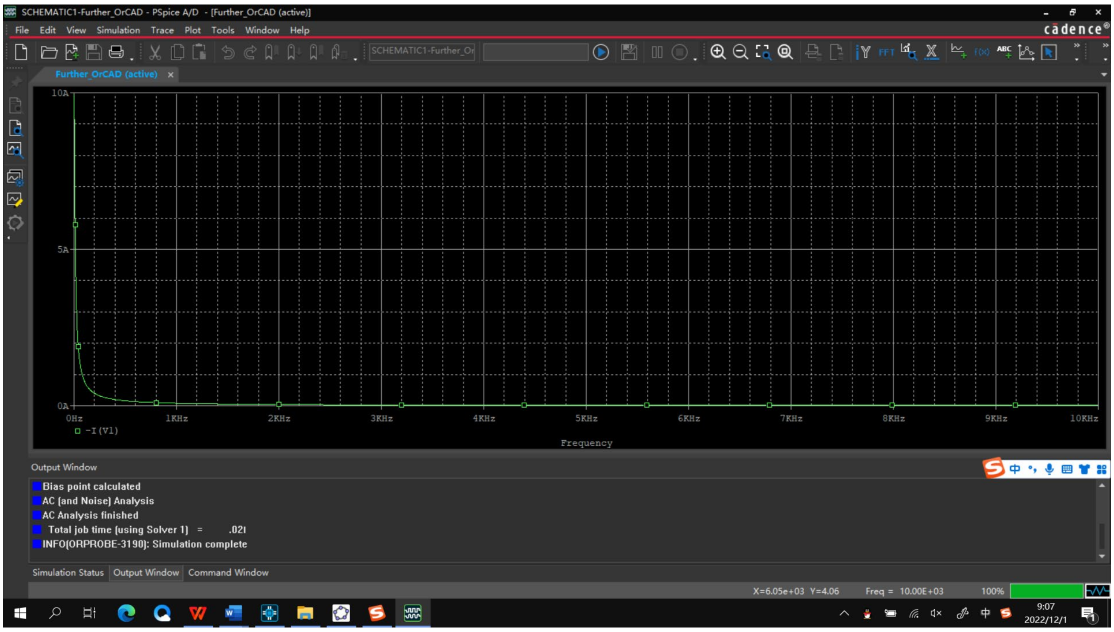


Finally, I use **X-axis log button** to receive a linear line.

5.



This is circuit diagram of AC source. The inductance is parallel with resistance.



Before I enter **X-axis log button**, this is the simulate result.

Firstly, I made a **preliminary analysis**.

$$\boldsymbol{I} = \frac{\boldsymbol{V}}{X_L} = \frac{\boldsymbol{V}}{j\omega L}$$

If the frequency is exceedingly high, the current through the inductance will be exceedingly small, to 0A. The current will only through the R_2 resistance. Thus, the current will decrease if the frequency is increasingly high.

In addition, **detailed analysis** with formula.

$$\boldsymbol{I} = \frac{V}{Z_T}$$

Since the inductance is connected in series with R_1, it is connected in parallel with R_2.

$$\frac{1}{Z_T} = \frac{1}{R_1} + \frac{1}{R_2 + j\omega L} = \frac{\sqrt{{R_2}^2 + (\omega L)^2} + R_1}{R_1\sqrt{{R_2}^2 + (\omega L)^2}}$$

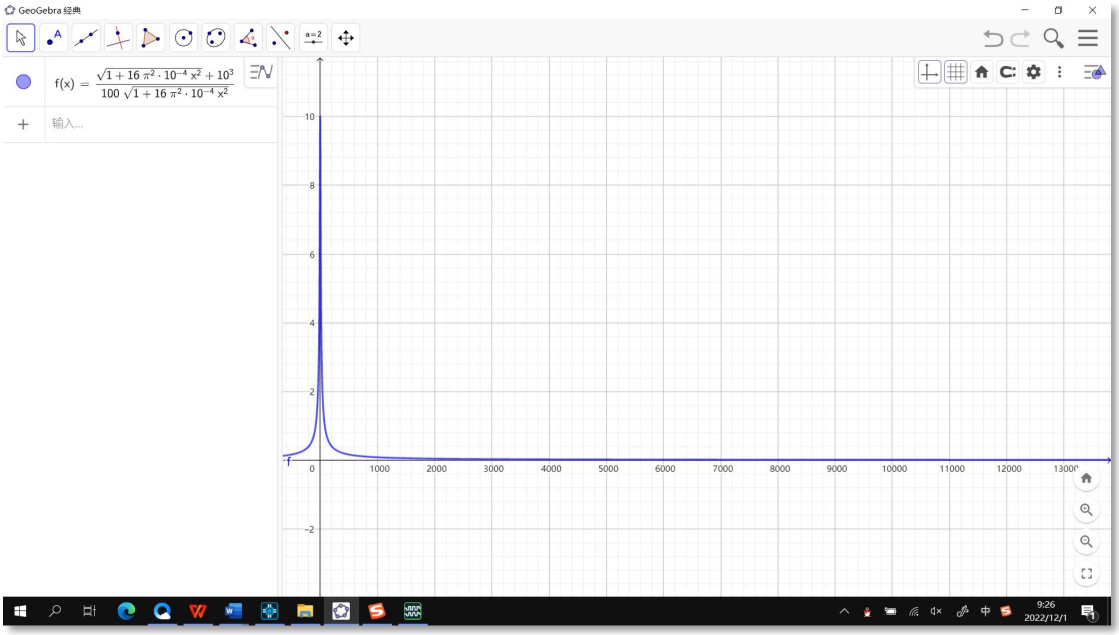
$$\boldsymbol{I} = V \times \frac{\sqrt{{R_2}^2 + (\omega L)^2} + R_1}{R_1\sqrt{{R_2}^2 + (\omega L)^2}}$$

In this circuit, $\boldsymbol{V = 10v}$, $\boldsymbol{R_1 = 1k\Omega, R_2 = 1\Omega, L = 20mH}$.

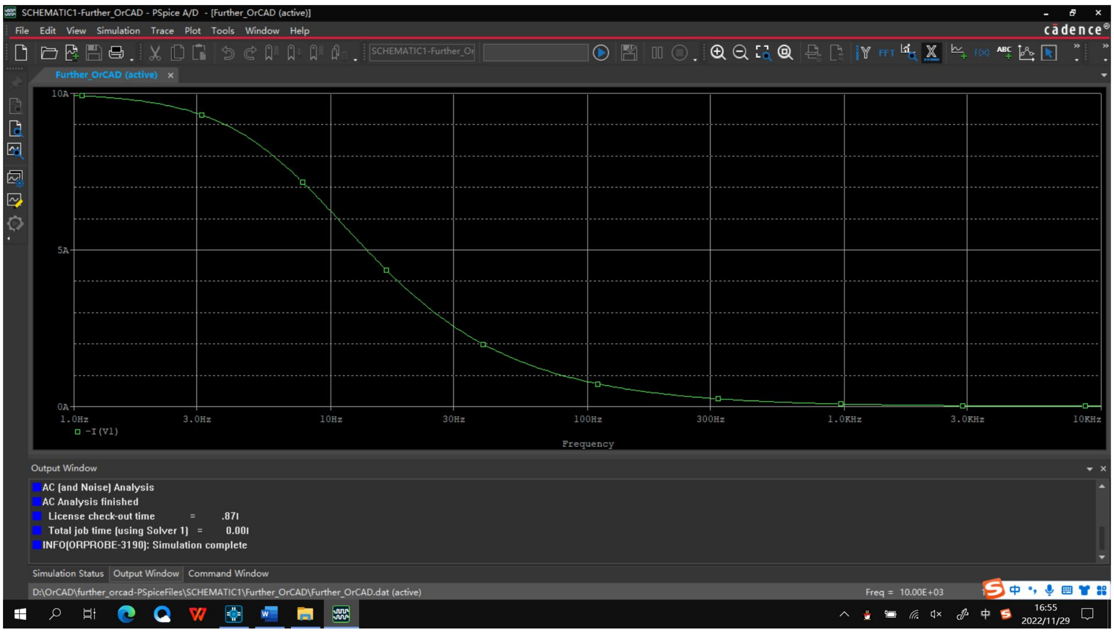
Thus, the calculation formula is

$$\boldsymbol{I} = 10 \times \frac{\sqrt{1 + 16\pi^2 \times 10^{-4} f^2} + 10^3}{10^3 \sqrt{1 + 16\pi^2 \times 10^{-4} f^2}}$$

Simulate formulas using drawing software.

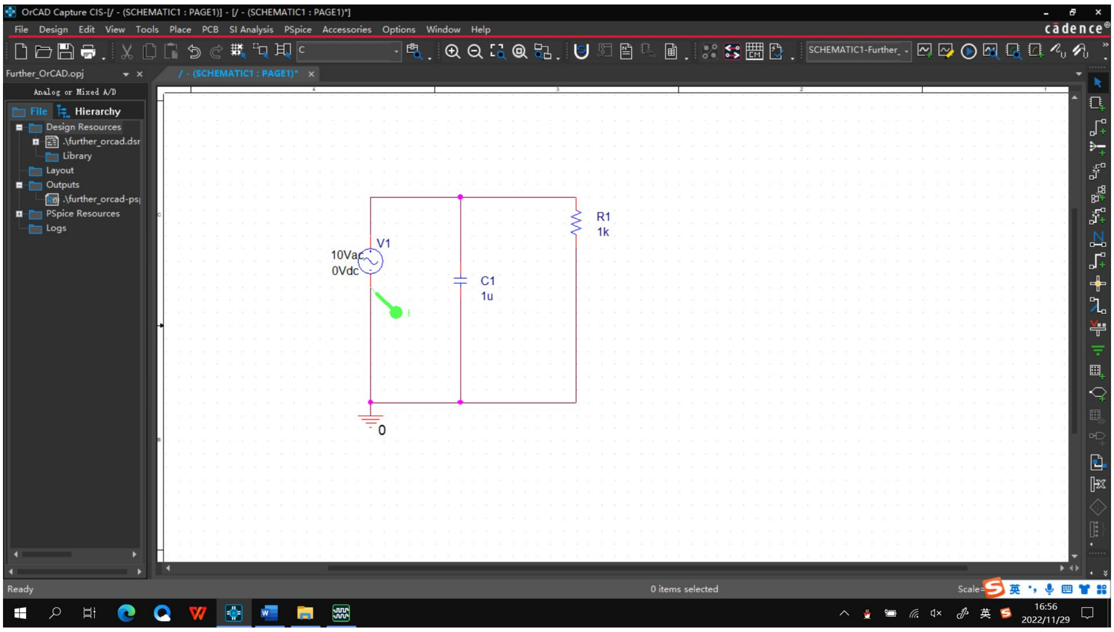


Thus, I can find that the formula graph is the same as the circuit simulate result.

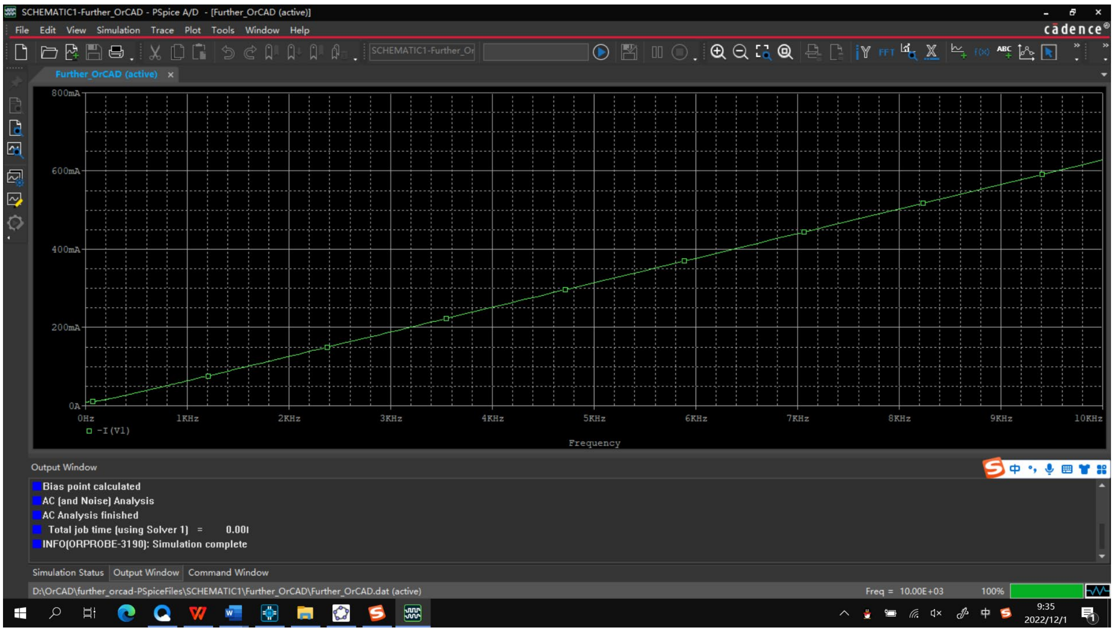


Finally, I use **X-axis log button** to receive a linear line.

6.



This is circuit diagram of AC source. The capacitor is parallel with resistance



This is the simulate result which I do not enter the **X-axis log button.**

I **detailed analysis** with formula.

$$\boldsymbol{I} = \frac{V}{Z_T}$$

$$\frac{1}{Z_T} = \frac{1}{Z_R} + \frac{1}{Z_C} = \frac{Z_R + Z_C}{Z_R Z_C}$$

$$Z_R = R_1 \angle 0°, Z_C = \frac{1}{\omega C} \angle -90°$$

Thus

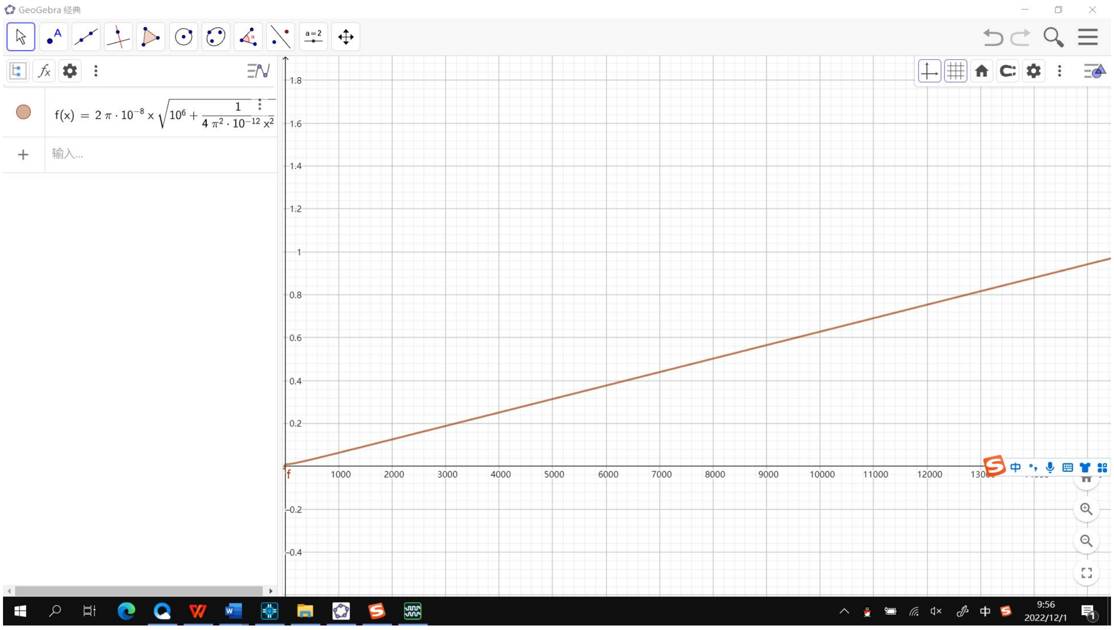
$$\frac{1}{Z_T} = \frac{\omega C \sqrt{{R_1}^2 + \frac{1}{(\omega C)^2}}}{R_1}$$

$$\boldsymbol{I} = V \frac{\omega C \sqrt{{R_1}^2 + \frac{1}{(\omega C)^2}}}{R_1}$$

In this circuit, $\boldsymbol{V = 10v, R_1 = 1k\Omega, C = 1uF}$.

Thus, the calculation formula is

$$\boldsymbol{I} = 10 \times \frac{2\pi \times 10^{-6} f \sqrt{10^6 + \frac{1}{4\pi^2 \times 10^{-12} f}}}{1000}$$



Thus, I can find that the formula graph is the same as the circuit simulate result.

Conclusion:

In this experiment, I verified the characteristics of diodes, inductors, and capacitors. Through the combination of theory and experiment, I have a better understanding of the characteristics of these components.