CHONGQING UNIVERSITY OF POSTS AND TELECOMMUNICATIONS

Thevenin And Maximum Power

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Module	**EE1616 Electronics Workshop**
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Introduction and aims:

To understand and apply the two pieces of theory taught in EE1618 Deceives and Circuits. Combine theory with practice. In addition, verify the Thevenin's theorem between DC and AC circuits. Try to find the corresponding resistance such that the load resistance reaches the maximum power, verify the maximum power transfer theorem.

Task description:

1. Use the Thevenin's theorem and maximum power transfer theorem to complete the three examples.
2. Verify the Thevenin's theorem.
3. Verify the maximum power transfer theorem. Follow the instructions to complete the task step by step.

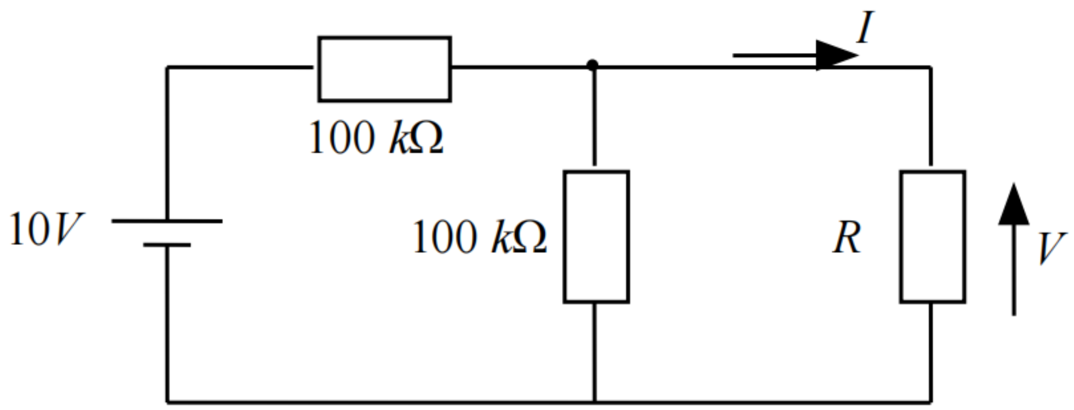
Experiment method:

1. Review the Thevenin's theorem and maximum power transfer theorem. We need to know what is R_{th} and V_{th}.
2. Verify the Thevenin's theorem. Change the value resistance, measure the value of voltage and current. Draw a table with the columns of R_{load}, *V*, *I* and *P*.
3. Verify the maximum power transfer theorem. Use parameter to control the value of load resistance.

Result and observation:

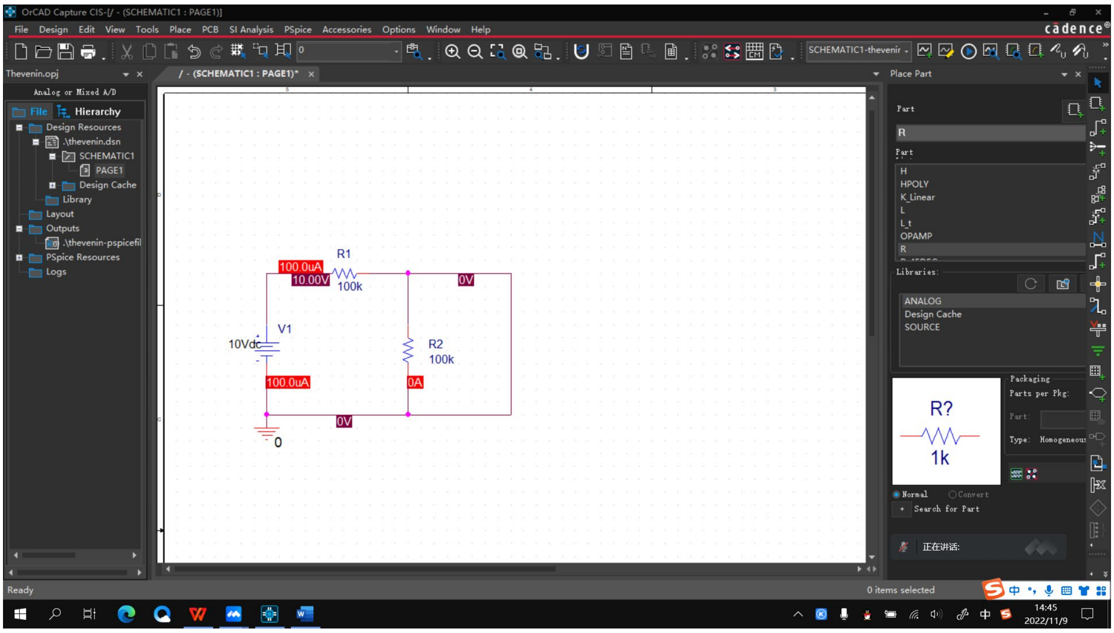
Examples:

1.



Theoretically, the Thevenin's equivalent resistance and voltage $R_{th} = 50k\Omega, E_{th} = 5V$.

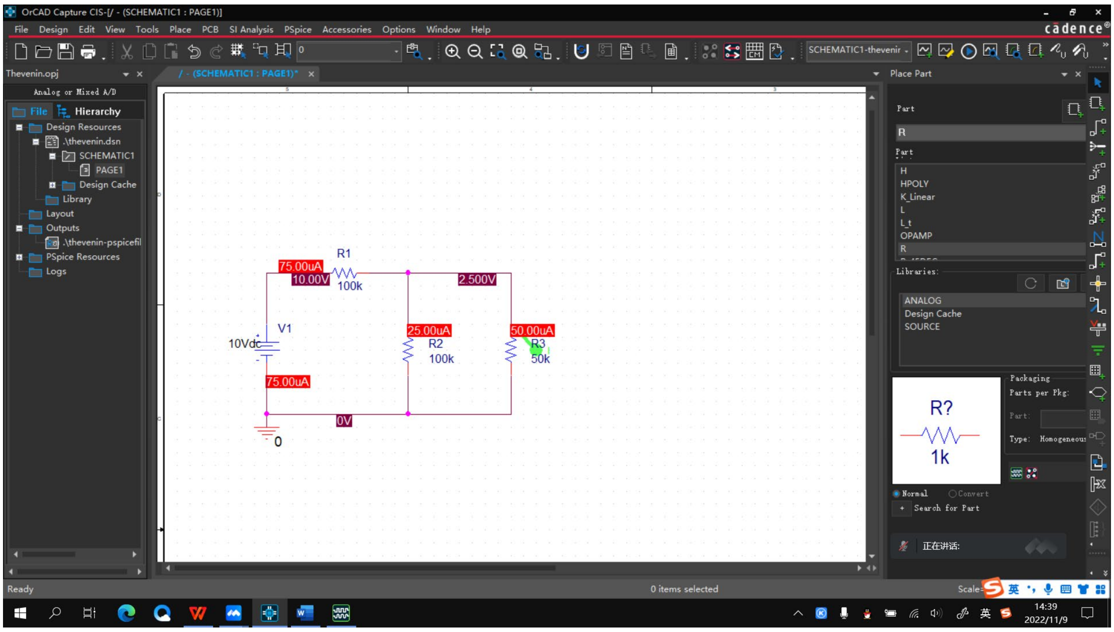
a) For zeroΩ



The corresponding voltage is 0V, the current is $100.0\mu A$.

Thus, the power $P = V * I = 0$.

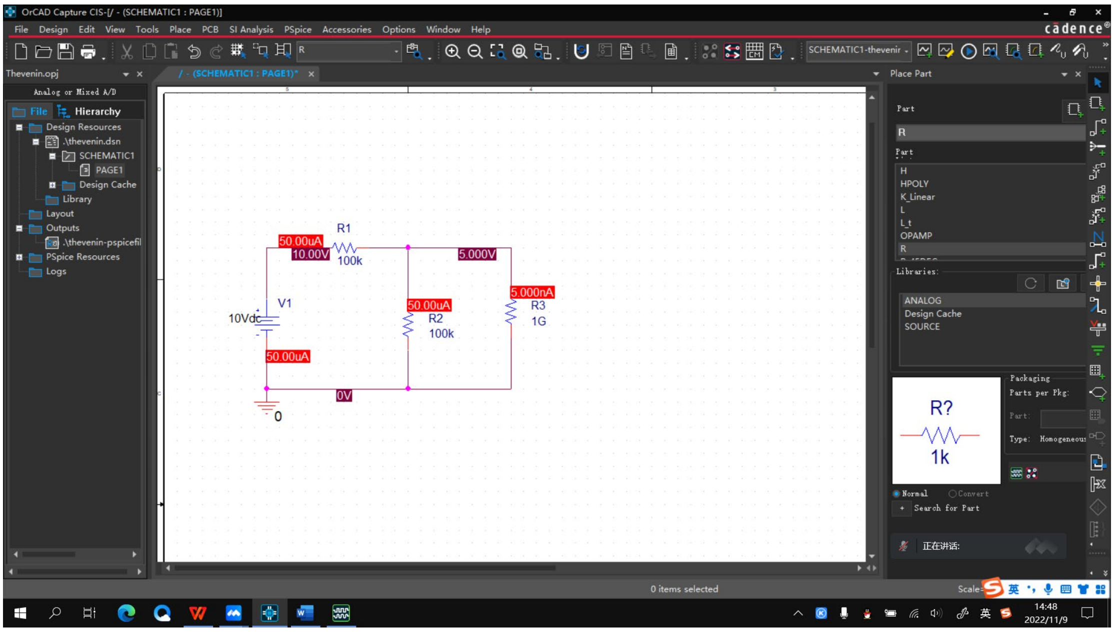
b) For 50kΩ



The corresponding voltage is 2.5V, the current is 50μA.

Thus, the power $P = V * I = 125\mu W$.

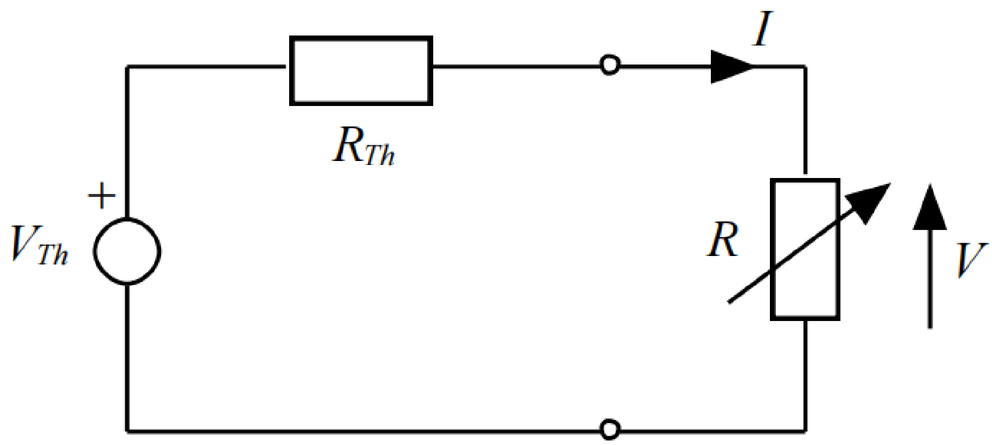
c) For infinity



The corresponding voltage is 5V, the current is 5nA. The current is nearly to 0, so we think the current is 0A and the two terminals is open circuit.

Thus, the power $P = V * I = 25nW \approx 0$.

2.



There are three equations to describe the relationship between each physical quantity.

$$V = IR$$

$$V = \frac{RV_{Th}}{R + R_{Th}}$$

$$I = \frac{V_{Th}}{R + R_{Th}}$$

3.

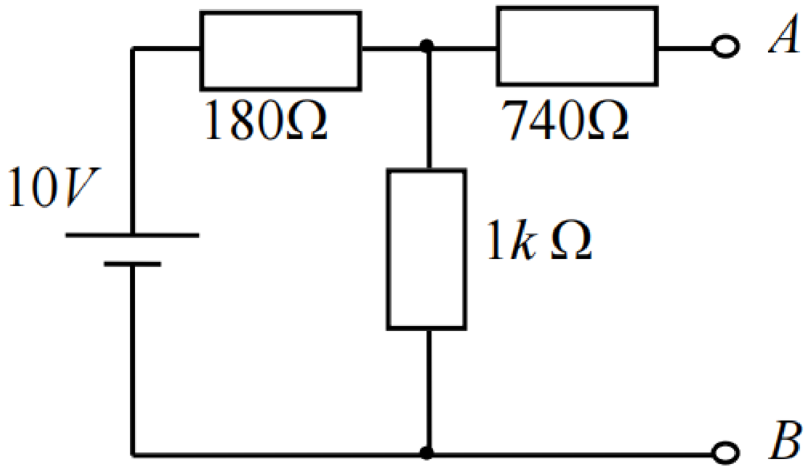


Figure 3

For the theory, $R_{Th} = 892.54\Omega, E_{Th} = 8.47V$.

Thus, the equivalent circuit diagram is:

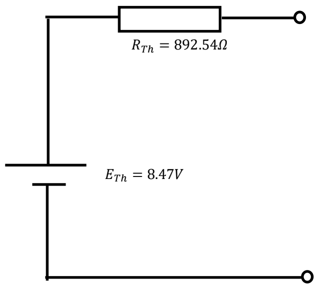


fig. 1. Thevenin's equivalent circuit

Equipment:

1) Verification of Thevenin's theorem

I change the value of the load resistance. The value for $R = 0\Omega, R = R_{Th}, R = \infty\Omega$ respectively.

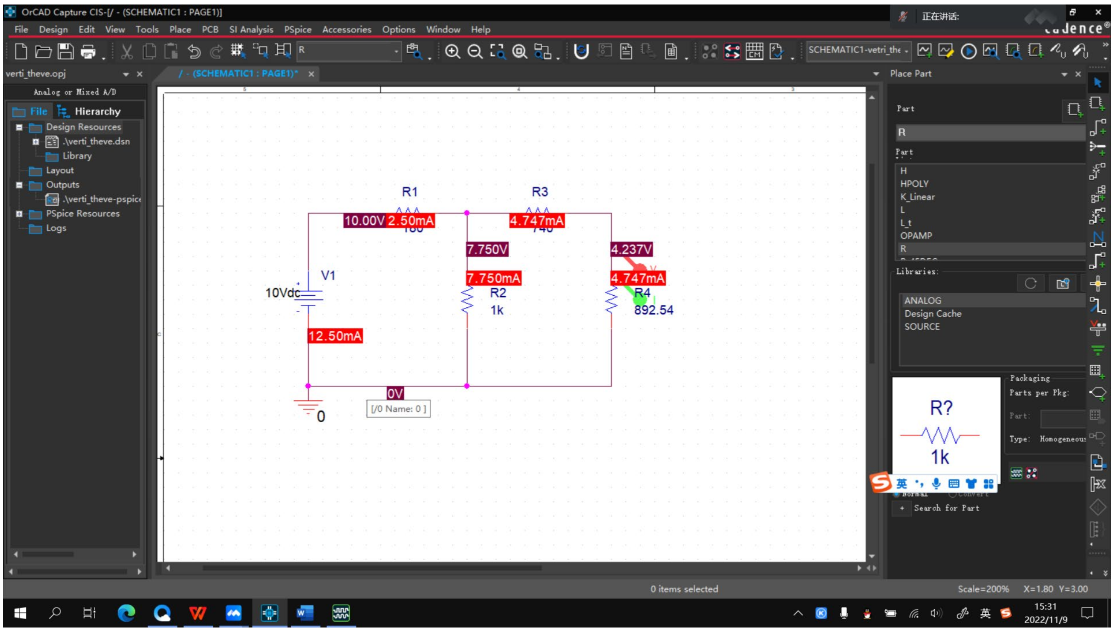


fig. 2. $R = R_{Th} = 892.54\Omega$

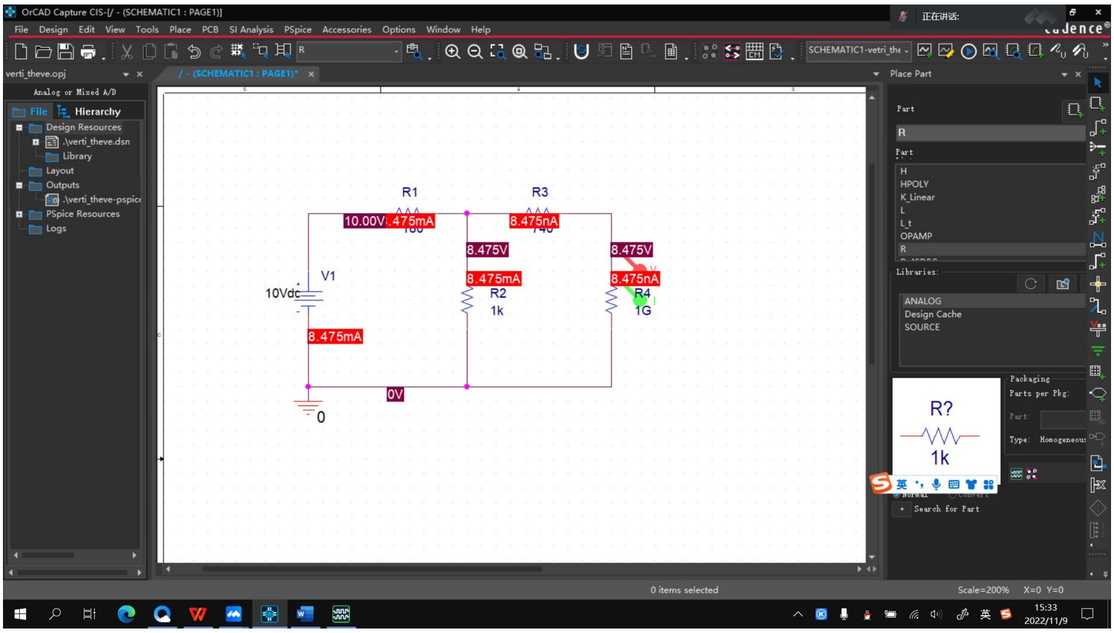


fig. 3. $R = \infty\Omega$

Then, I draw a table with the columns of R_{load}(Ohms), V(Volts), I(Amps) and P.

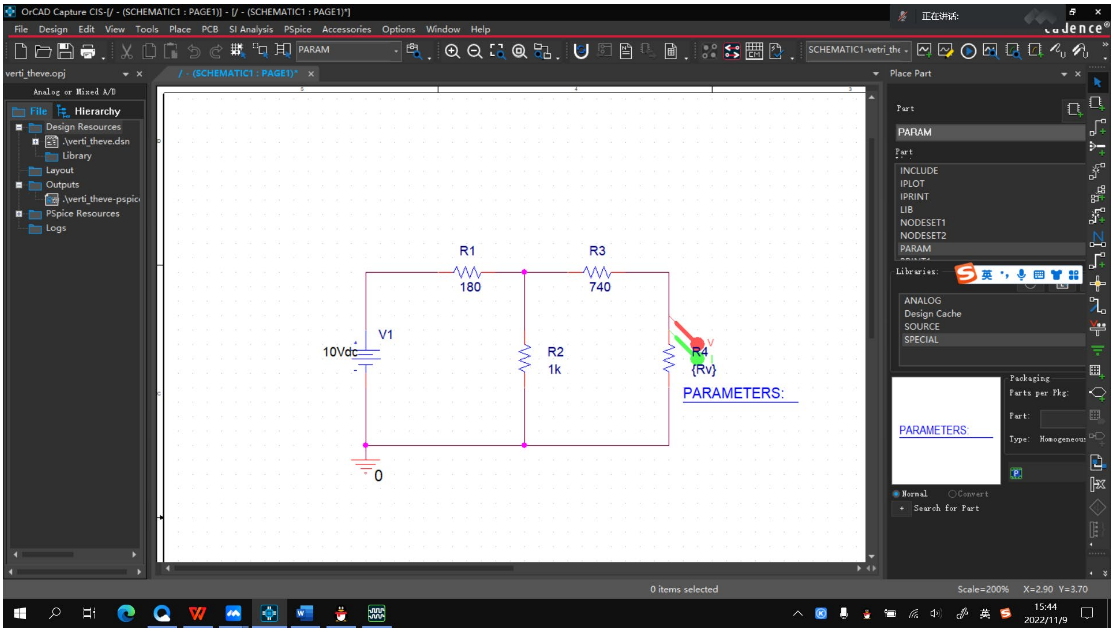
R_{load}	V	I	P
0	0	9.495mA	0
892.54	4.237V	4.747mA	20.113mW
1G ($\infty\Omega$)	8.475V	8.475nA	71.826nW

Thus, if the value of the load resistance is equal to the Thevenin's resistance, the voltage on the resistance is equal to the half of the Thevenin's voltage.

Therefore, **we can verify the Thevenin's theorem.**

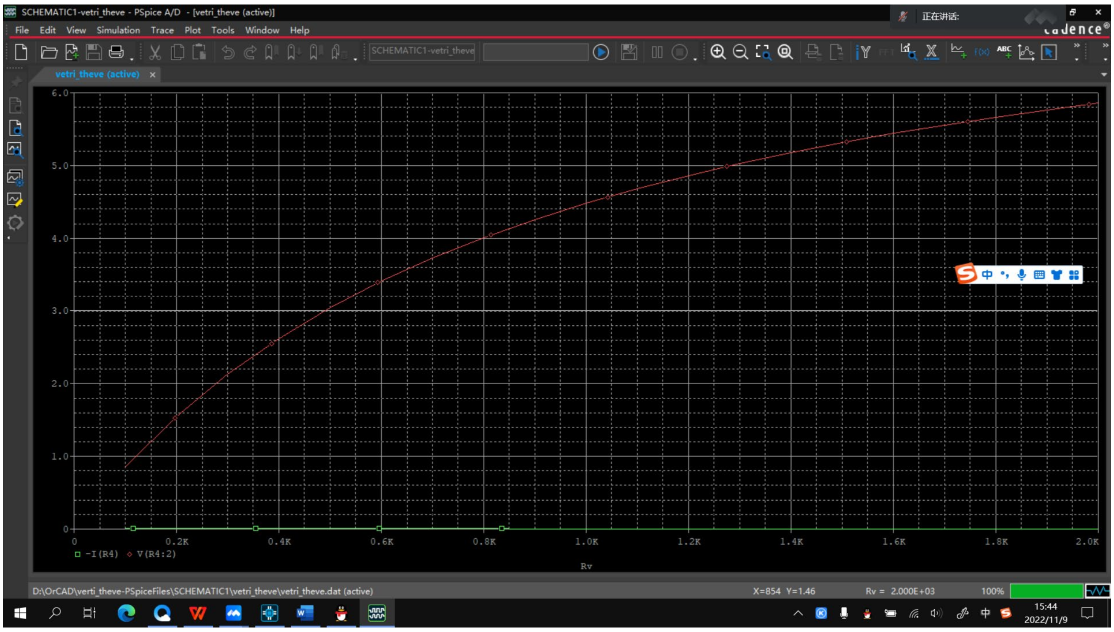
2) Maximum power transfer

This is my circuit diagram:

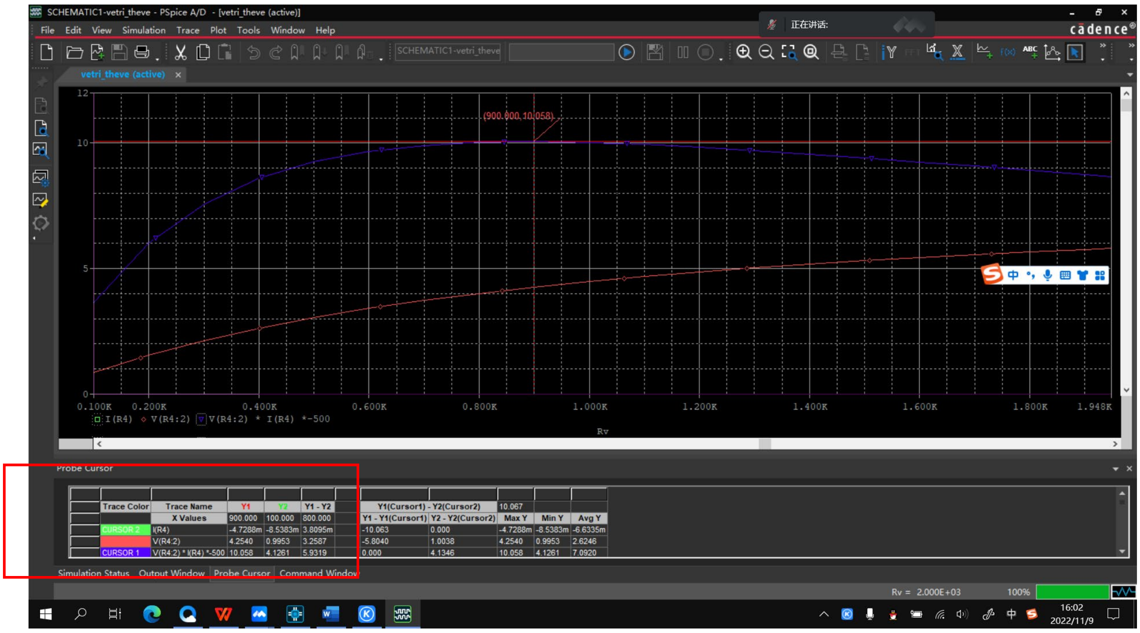


Firstly, I need set some parameters for the R4.

I set the **start value is 100Ω**, the **end value is $2k\Omega$**, and the **increment is 100Ω.**



This is the result of voltage and current. But we need find the maximum power, so I use some formula to calculate it.

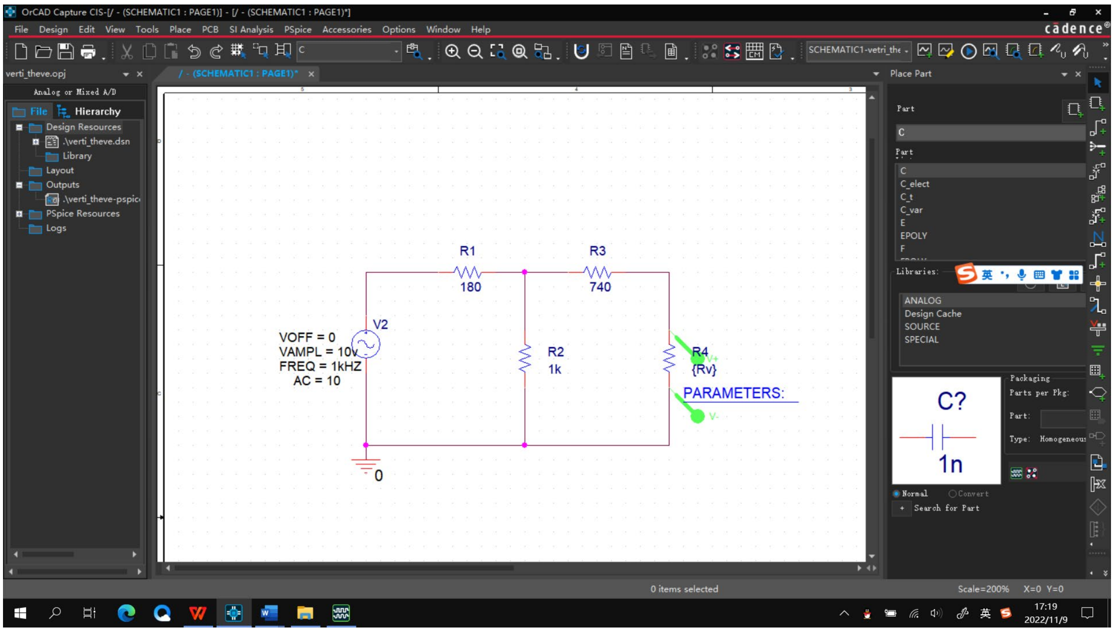


Because $P = V * I$. In this situation, the current is too small, if I directly times the V and I, the power curve is not clearly. So, I multiplied this formula by 500, $\boldsymbol{V * I * (-500)}$. Therefore, I can see the curve clearly.

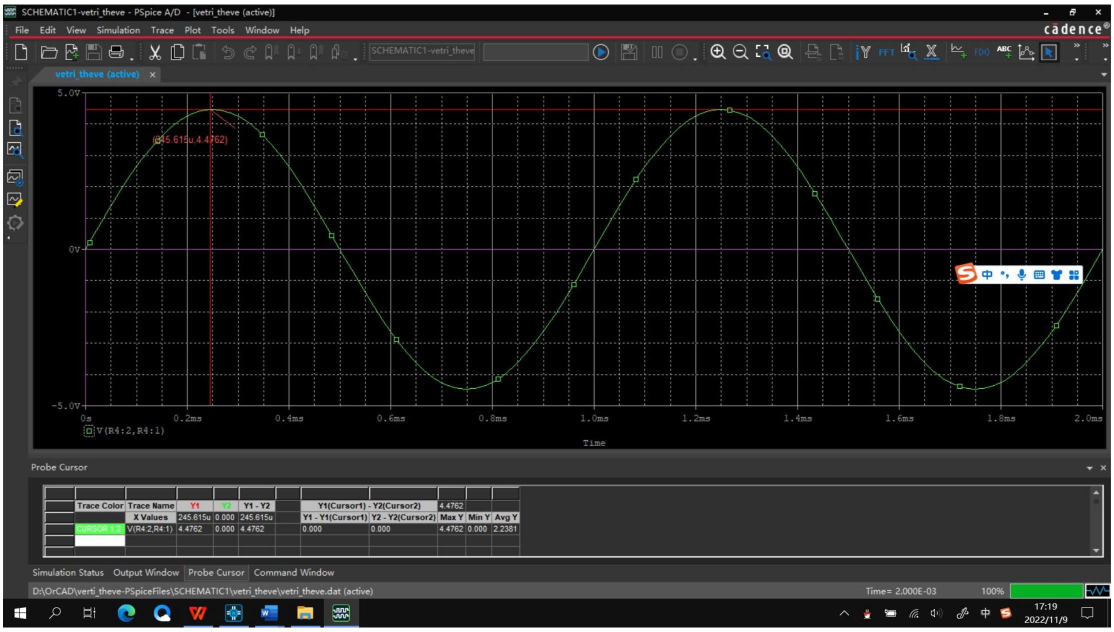
Use the computer, I can find the peak value of the power curve easily. At this point, the voltage is 4.2540V, the current is 4.7288mA, the load resistance is 900Ω, **the maximum power is 20.166mW.** The experiment data are very close to the real data. **Thus, we verify the maximum power transfer theorem.**

3) AC tests

This is my circuit diagram:

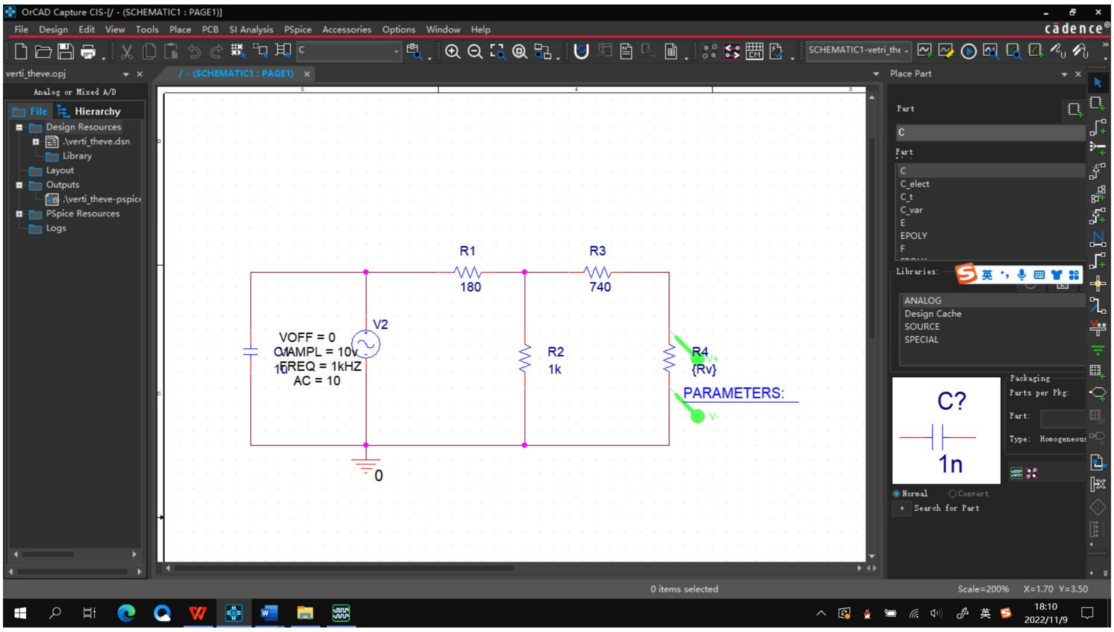


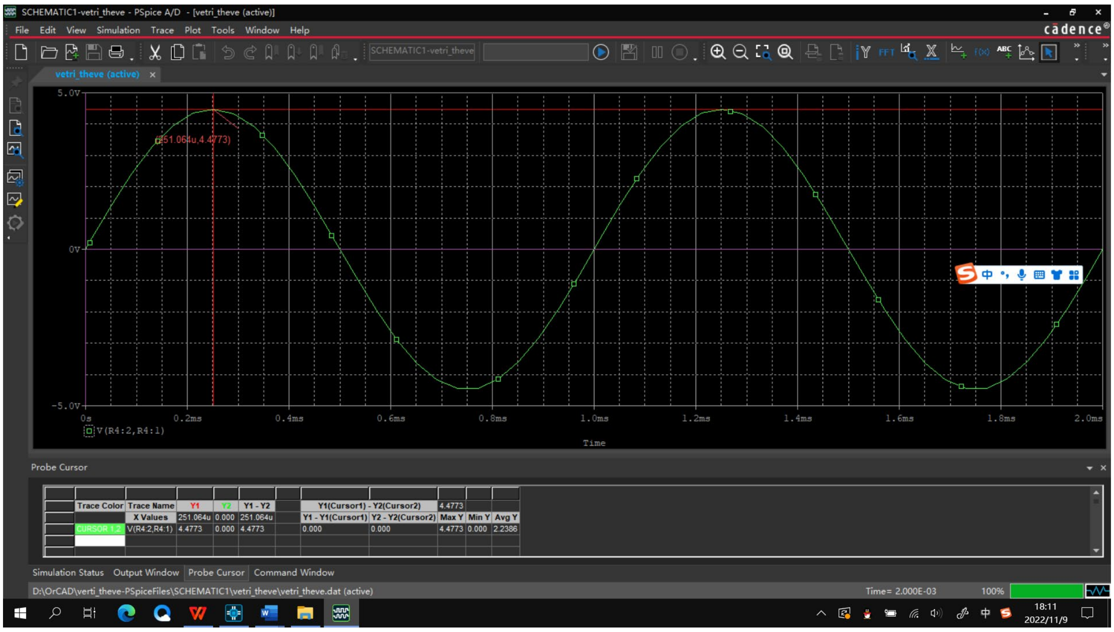
Before I add the capacitor, the result is:



I can find that the maximum voltage is 4.4762V. The result is corresponding to the previous data. **Thus, the Thevenin's theorem is still valid at a sinusoidal input.**

Then, I add a $1\mu F$ capacitor on the circuit:





The maximum voltage is 4.4773V. The result is also corresponding to the previous data. **Thus, the Thevenin's theorem is still valid.**

Conclusion:

In this lecture, I further understand Thevenin's theorem and the maximum power transfer theorem. I can verify the two pieces of theorems with OrCad software. I also know that Thevenin's theorem can also supply in AC circuits.