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ATTENTION: Mr.Wendong Li, Teacher of Technical Communication Skills

LABORATORY REPORT

PHYSICAL LAB REPORT: NONLINEAR DEVICES AND CHAOS

INTRODUCTORY SUMMARY

We have already learned the principle of chaos and the relevant circuit. Though this lab,we have three purposes:

1.To get familiar with the nonlinear devices and the phenomenon in chaos.

2.To learn to use the devices about nonlinear and chaos.

3.To get familiar with Origin and use it to deal with data.

Also, after the experiment, I will explan how to understand the random behaviors of chaos and presenet the physical meanings of the double-period bifurcation based on this experiment.

LAB MATERIALS

Oscilloscope, digital multimeter, DC stabilized power supply, inductance, capacitance, potentiometer, resistance box, conductor.

LAB PROCEDURE & ANALYSIS

1 Detector diode

a) Forward V-A curve: construct circuitry using the breadboard as in the [Figure 1] below. Use a current limiting resistor to protect the diode. Limit I<20 mA and U<1.2 V. Use the multimeter as a current meter, and use the voltage supply reading to get the voltage. Take 20 data points. Make the V-A curve.

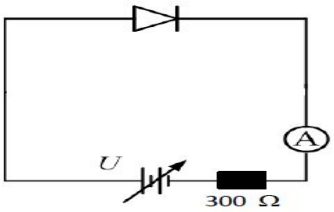


Figure 1

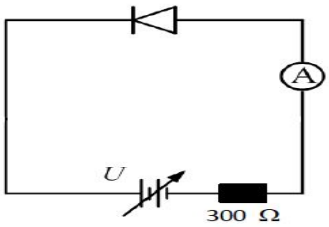


Figure 2

b) Reverse V-A curve: construct circuitry using the breadboard as in the [Figure 2] below. Use a current limiting resistor to protect the diode. Limit I<20 mA and U<20 V. Use the multimeter as a current meter, and use the voltage supply reading to get the voltage. Take 10 data points. Make the V-A curve.

c) Note that the supplied voltage will be divided between the resistor and the diode. Can you make a correction to the 300 Ohm resistor when making the V-A curve?

We get the following data:

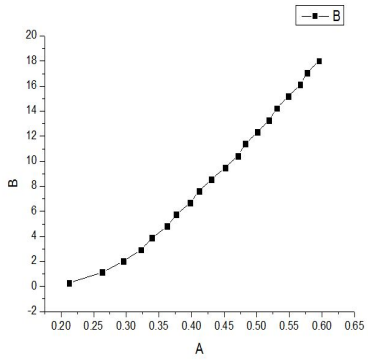
U/V	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
I/mA	0.292	1.122	2.015	2.925	3.868	4.792	5.744	6.674	7.628	8.564
U/V	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00
I/mA	9.495	10.430	11.391	12.330	13.271	14.231	15.172	16.111	17.076	18.015

After we subtract the voltage of protective resistance, we get:

U/V	0.2124	0.2634	0.2955	0.3225	0.3396	0.3624	0.3768	0.3978	0.4116	0.4308
I/mA	0.292	1.122	2.015	2.925	3.868	4.792	5.744	6.674	7.628	8.564
U/V	0.4515	0.471	0.4827	0.501	0.5187	0.5307	0.5484	0.5667	0.5772	0.5955
I/mA	9.495	10.430	11.391	12.330	13.271	14.231	15.172	16.111	17.076	18.015

Use Origin to get the graph:

Reverse :After the experiment, we get the following data[Data 1]:

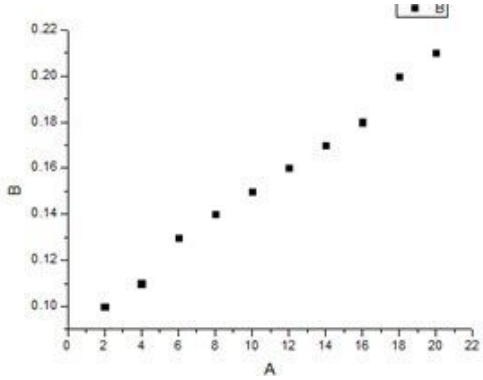


[Graph 2]

U/V	I/μA	U/A	I/μA
2.00	0.10	12.00	0.16
4.00	0.11	14.00	0.17
6.00	0.13	16.00	0.18
8.00	0.14	18.00	0.20
10.00	0.15	20.00	0.21

[Data 1]

After we subtract the voltage of protective resistance, we get:



[Graph 2]

U/V	I/μA	U/V	I/μA
1.99997	0.10	11.99995	0.16
3.999967	0.11	13.99995	0.17
5.999961	0.13	15.99995	0.18
7.999958	0.14	17.99994	0.20
9.999955	0.15	19.99994	0.21

[Data 2]

Then the graph of reverse V-A curve is[Graph 2]:

2.Rectifier diode: repeat above. In the forward V-A curve, limit U<1.0 V.
Data Analysis and Graph:

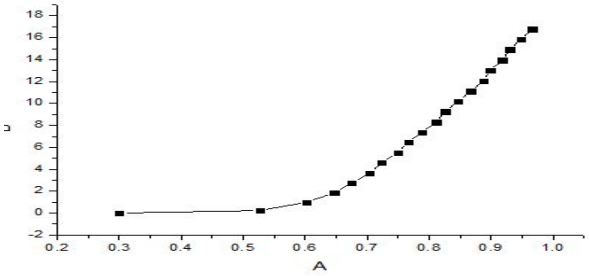
Forward: After the experiment, we get the following data:

Voltage (V)	Current(mA)	Voltage (V)	Current(mA)	Voltage (V)	Current(mA)	Voltage (V)	Current(mA)
0.30	0.001	1.80	3.653	3.30	8.297	4.80	13.006
0.60	0.245	2.10	4.589	3.60	9.249	5.10	13.941
0.90	0.992	2.40	5.504	3.90	10.178	5.40	14.900
1.20	1.846	2.70	6.447	4.20	11.110	5.70	15.841
1.50	2.751	3.00	7.371	4.50	12.044	6.00	16.781

After we subtract the voltage of protective resistance, we get:

Voltage (V)	Current(mA)	Voltage (V)	Current(mA)	Voltage (V)	Current(mA)	Voltage (V)	Current(mA)
0.2997	0.001	0.7041	3.653	0.8109	8.297	0.8982	13.006
0.5265	0.245	0.7233	4.589	0.8253	9.249	0.9177	13.941
0.6024	0.992	0.7488	5.504	0.8466	10.178	0.93	14.900
0.6462	1.846	0.7659	6.447	0.867	11.110	0.9477	15.841
0.6747	2.751	0.7887	7.371	0.8868	12.044	0.9657	16.781

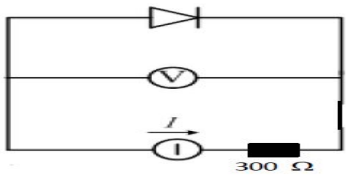
Use Origin to get the graph:



This is the forward V-A curve of the rectifier diode.

3. Zener diode:

Construct a reversed biased circuitry as shown in the figure below. In this we use constant current supply. Use the multimeter to measure the voltage, the reading of the supply current as the current. Vary the current from 0 to <30 mA 20 times, and record the V-A data. Make the V-A curve.



Data Analysis and Graph:

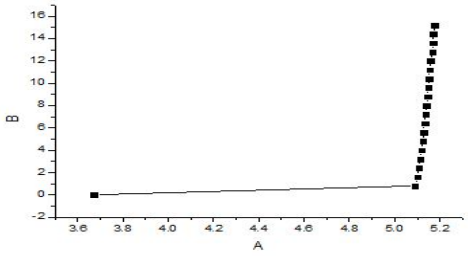
After the experiment, we get the following data:

I/mA	U/V	I/mA	U/V	I/mA	U/V	I/mA	U/V
0.001	3.670	4.002	6.319	8.000	7.541	12.001	8.759
0.802	5.329	4.801	6.564	8.799	7.785	12.802	9.006
1.602	5.581	5.598	6.807	9.601	8.029	13.602	9.249
2.399	5.827	6.401	7.052	10.400	8.272	14.400	9.491
3.201	6.073	7.201	7.297	11.202	8.516	15.200	9.734

After we subtract the voltage of protective resistance, we get:

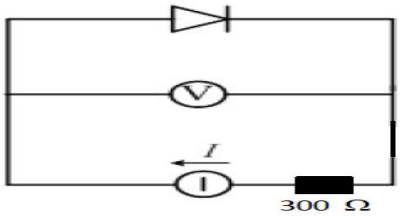
I/mA	U/V	I/mA	U/V	I/mA	U/V	I/mA	U/V
0.001	3.6697	4.002	5.1184	8.000	5.141	12.001	5.1587
0.802	5.0884	4.801	5.1237	8.799	5.1453	12.802	5.1654
1.602	5.1004	5.598	5.1276	9.601	5.1487	13.602	5.1684
2.399	5.1073	6.401	5.1317	10.400	5.152	14.400	5.171
3.201	5.1127	7.201	5.1367	11.202	5.1554	15.200	5.174

Use Origin to get the graph:

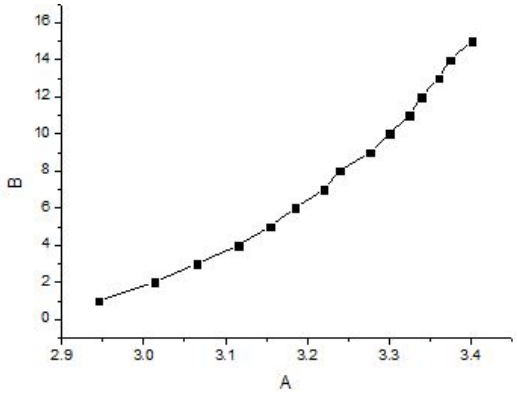


4. LED:

Select four LEDs with different colors to perform this measurement. Measure the V-A curve using the diagram in the figure below, and find the turn-on voltage. Make sure that I<20 mA, V<3 V, and take 15 points each. Use $eU_0 = hc/\lambda$ to estimate the wavelength of the photons.

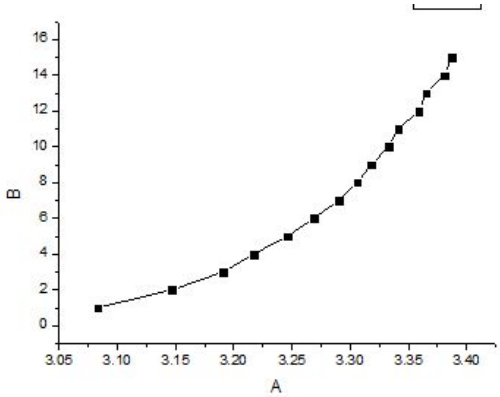


Blue:Use Origin to get the graph:



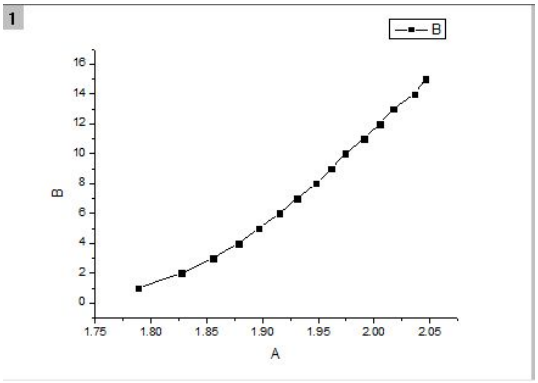
And we get U_0=2.769V

Purple:Use Origin to get the graph:

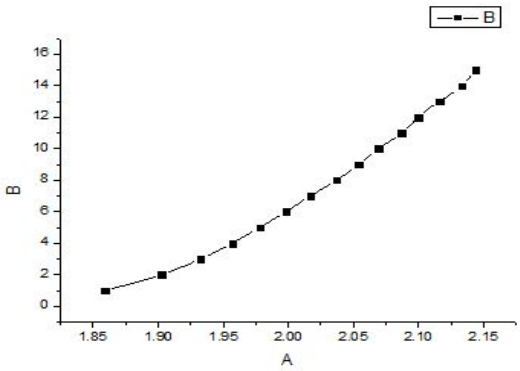


And we get U_0=3.147V

Yellow:Use Origin to get the graph:



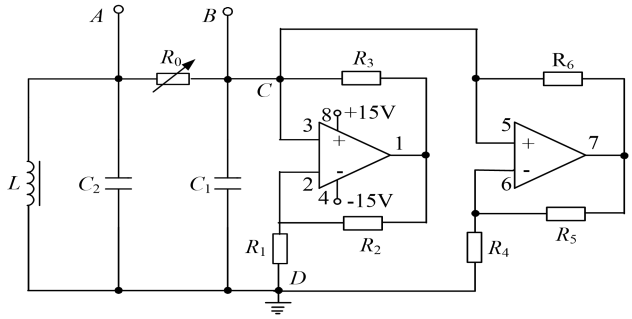
And we get U_0=1.9151V
Green:Use Origin to get the graph:

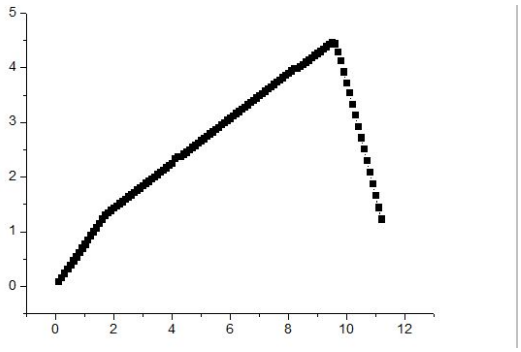


Analysis:When we measure green and yellow LED, maybe there is something wrong with the devices or the value on the meter is unstable when we record the data, thus our wavelength is different from the real value.

Chaos

Experimentally, one can achieve nonlinear resistor with a two-stage opamp circuit as shown in the figure below. There are positive and negative feedbacks in both stages. Specifically, R_3/R_0 and R_6/R_0 control the amplitude of the positive feedbacks, and R_2/R_1 and R_5/R_4 control the amplitude of the negative feedbacks.

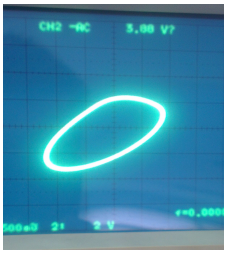




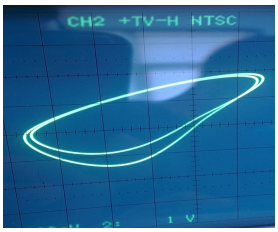
I take data with 0.1 V steps with V less than 13 V.I have gotten 120 data,which is too long.

So I omit them.I use Origin to get the graph:

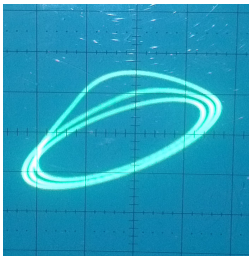
This is the V-A curve of the nonlinear devices.



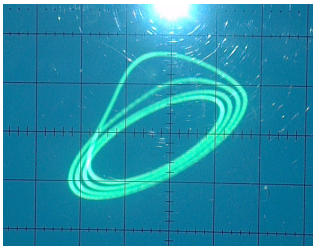
[period 1]



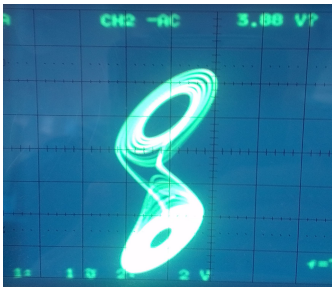
[period2]



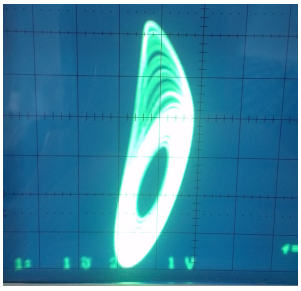
[period3]



[period4]



[so-called “Bufferfly” state]



[a single attractor state]

PROBLEM SOLVING

1.How to understand the random behavior of chaos?

Because chaos is a system that occurs in the system of seemingly random irregular movements, a deterministic theory describes the behavior of which is uncertain and unpredictable.. The chaos appears to be random, but it is certain.. Because of its sensitivity to the initial value, only a slight change of the initial value can be the result of rapid changes. Chaos is the random behavior of the system.. Chaotic behavior of the main feature is sensitive dependence on initial conditions, and chaotic randomness and non cycle of the sensitive dependence on initial conditions for determining chaos system, from the point of view of the evolution of a deterministic nonlinear system, they behavior in the chaotic region showed the randomness and uncertainty. However, this uncertainty is not from the external environment of the random factors, but the system naturally occurring.

2.Present the physical meanings of the double-period bifurcation based on this experiment.

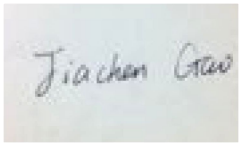
Chaos is a necessary condition for the occurrence of is system with nonlinear factors, listed in the circuit in the nonlinear differential equations generally no analytical solution and computer simulation equation, because the reactance of the nonlinear element is constantly changing, system to fixed point solutions of the periodic to chaotic, period doubling bifurcation process is a leading to chaotic visible Road, it is considered that is from the periodic window into the chaos of a way. The process of chaos phenomenon through the period of bifurcation.. The chaos phenomenon is produced in the non integrable system, because the long-term value of the solution is sensitive to the initial value, and the behavior of the shape of the equation is similar.

CONCLUSION

Through the experiment, I understand to generate chaotic I-V characteristic curve of nonlinear circuit and the characteristics of the chaos circuit, timing diagram obtained by computer simulation, and different timing diagrams corresponding to the cycle. From the experiment, it can get the phenomenon and the basic characteristic, and analyze the concept and the significance of the signal period and the bifurcation.

I will phone you this week to see if you have any questions about our study. If you need information before them, please give me a call.

Sincerely,



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