Student ID: 523031910521 **Name:** 刘浩岸

Lab 4 Measurement of AC Parameters

Attention:
1. Before you turn on the power supply every time, Set the voltage regulator to zero output.
2. Do not reconnect the circuit before you turn off the power.
3. Do not touch the metal part.

4.1 Goals for the AC Lab:

1. Learn to how to operate equipment at 220V safely.
2. Learn to get parameters by measurement.

4.2 Experiment 1: Get parameter by Voltmeter, Ammeter and Power meter

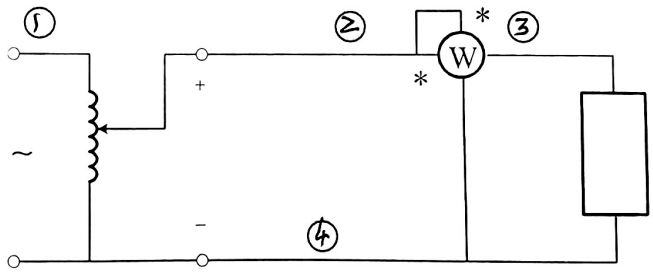

Fig.1 Get parameter by Voltmeter, Ammeter and Power meter

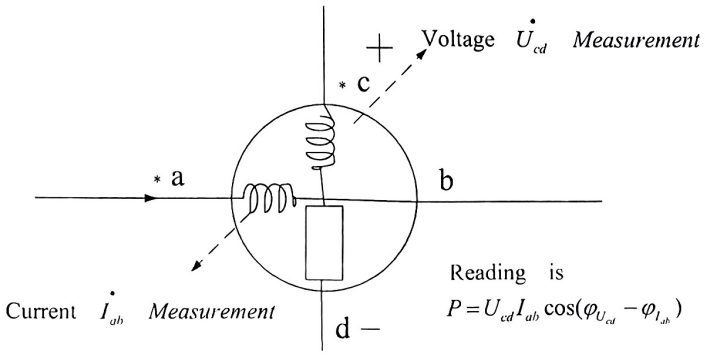

Fig.2 Power meter diagram

4.2.1 Resistor measurement

Set the voltage regulator to zero output.
For resistor,

$$\dot{U} = R\dot{I}$$

Average power is

$$P = UI = RI^2$$

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I/A	U/V	P/W	$R=\frac{U}{I}/\Omega$	$R=\frac{U^2}{P}/\Omega$
0.5	50.4	25.0	100.8	101.6
0.7	70.4	49.0	100.6	101.1
0.9	90.4	81.0	100.4	100.9
平均			100.6	101.2

4.2.2 Capacitor measurement

Set the voltage regulator to zero output.

For capacitor $C=12\mu F$,

$$\dot{U}=-j\frac{1}{\omega C}\dot{I}=-jX_C\dot{I}=\frac{\dot{I}}{\omega C}\angle-90°$$

$$C=\frac{I}{2\pi fU}$$

Average power is zero.

Table 5.7.2 Capacitor Measurement

U/V	I/A	$C/\mu F$ (calculated)	P/W
160	0.595	11.84	~~0.2~~ 0.1
180	0.670	11.85	0.3
200	0.741	11.80	0.2

95.2Var

120.4Var

148.1Var

4.2.3 Inductor measurement

The model of real inductor consists of inductance and resistance in series,

$$Z_L=R_L+jX_L=|Z_L|\angle\phi_L$$

and

$$|Z_L|=\frac{U}{I}$$

$$P=UI\cos\phi=I\cdot|Z_L|\cdot I\cos\phi_L=I^2R_L$$

0.261

0.259

$$\cos\phi_L=\frac{P}{UI}$$

So

$$R_L=\frac{P}{I^2}=|Z_L|\cos\phi_L$$

$$X_L=\sqrt{|Z_L|^2-R_L^2}=|Z_L|\sin\phi_L$$

Then

$$L=\frac{X_L}{\omega}=\frac{X_L}{2\pi f}$$

Set the voltage regulator at zero output.

Table 5.7.3 Inductor Measurement

I/A	U/V	P/W	R_L/Ω(calculated)	L/H(calculated)
0.503	9.9	1.3	3.14	0.058
0.7	13.8	2.5	5.10	0.059
0.901	17.7	4.2	5.17	0.058

4.2.4 Impedance of RLC in series

Connect resistor, capacitor and inductor in series.

$$Z=(R+R_L)+j(X_L-X_C)=R'+jX=|Z|\angle\phi$$

100.

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If $U_L > U_C$, then$X_L > X_C$.The impedance is inductive.

Table 5.7.4 Impedance Measurement

I/A	P/W	U/V	U_R/V	U_C/V	U_L/V	$Z = R + jX$
0.5	26.3	137.4	50.2	136.4	10.1	108.1 -254.3j
0.7	51.5	192.4	70.1	191.0	14.1	107.8-254.4j
0.9	85.4	247.2	90.1	246.5	18.1	107.8-255.5j

4.3 Experiment 2: Inductor measurement with three voltmeter method

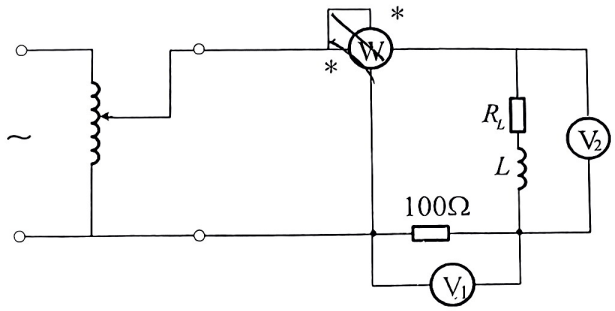

Fig.3 Inductor measurement with three voltmeter method

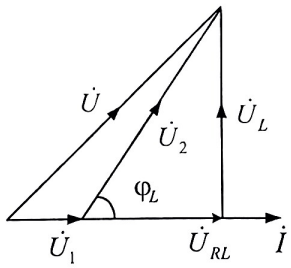

Fig.4 Phasor diagram showing 3 voltmeter method

$$U^2 = (U_1 + U_2\cos\phi_L)^2 + (U_2\sin\phi_L)^2$$

$$\cos\phi_L = \frac{U^2 - U_1^2 - U_2^2}{2U_1U_2}$$

0.267
0.269.

$$|Z_L| = \frac{U_2}{I}$$

$$R_L = |Z_L|\cos\phi_L = \frac{U_2}{I}\cos\phi_L$$

$$L = \frac{X_L}{2\pi f} = \frac{1}{2\pi f}\sqrt{|Z_L|^2 - {R_L}^2}$$

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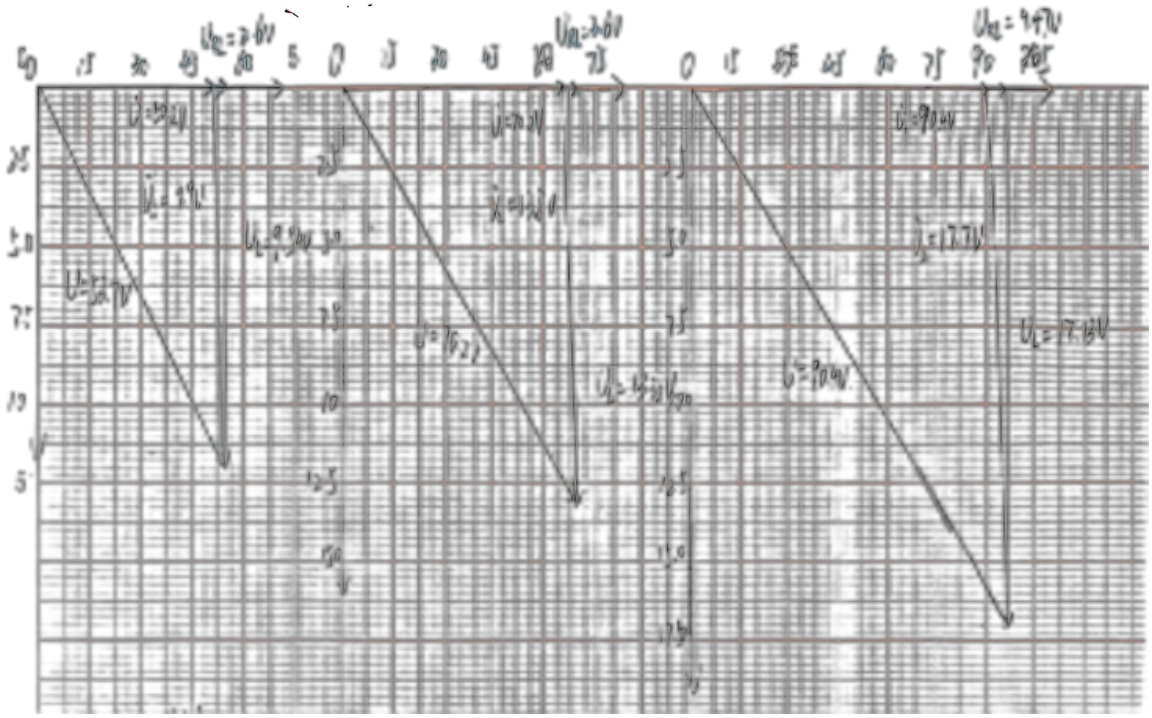
Table 5.7.5 Inductor Measurement by three voltmeter method

I/A	U/V	U_1/V	U_2/V	R_L/Ω (calculated)	L/H (calculated)
0.5	53.7	50.2	9.9	~~1539.07~~ ~~28.40~~ 5.28	0.061
0.7	75.0	70.1	13.8	~~2161.67~~ 5.16	0.061
0.9	96.4	90.2	17.7	~~2777.56~~ 4.95	0.061

Draw three phasor diagrams according Table 5.7.5.



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Lab 5 Power factor correction

5.1 Goal:

1. Learn how to increasing the power factor.
2. Learn how to use a power meter and a power factor meter.
3. Learn how to connect a fluorescent lamp circuit.

5.2 Experiment 1.connect the fluorescent lamp circuit

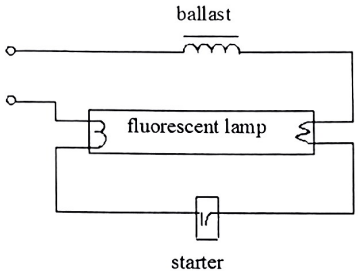

Fig.1 fluorescent tube circuit

The ballast is an inductor which should be connected with fluorescent lamp in series, while the starter connects with fluorescent lamp in parallel.

5.3 Experiment 2. Power factor correction

The line loss of the transmission line is

$$P_l = R_l I^2 \qquad \text{Equation 5-1}$$

U_L is effective value of the load voltage. The average power of a load is

$$P_L = U_L \ I \cos\phi \qquad \text{Equation 5-2}$$

Load current is

$$I = \frac{P_L}{U_L \ \cos\phi},$$

So $P_l = R_l(\frac{P_L}{U_L \ \cos\phi})^2$, increase power factor cosØ, decrease the line loss.

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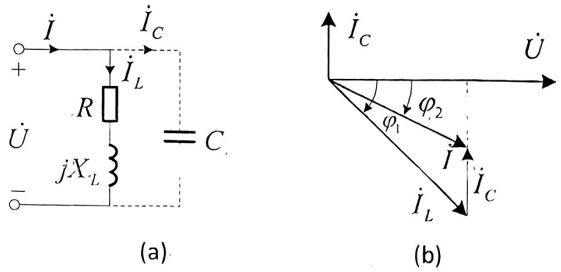

Fig.1 Power factor correction

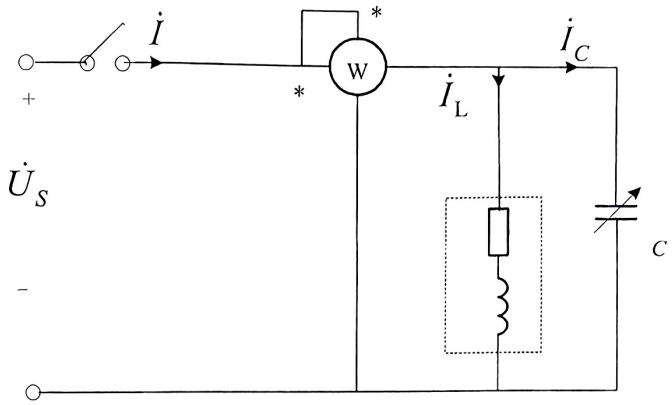

Fig.2 Inductive load with improved power factor

1. Connect to power supply 220V.
2. Set capacitance is zero, $C = 0\mu F$
3. Turn on the power supply.

Table 5.8.1 Original instructive load

I/A	U/V	P/W	$\cos\phi = \frac{P}{UI}$	$U_R = U\cos\phi$ /V	$U_L = U\sin\phi$ /V
0.286	220.0	27.2	0.432	95.04	178.94

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4. Set capacitor is C=1、2、3.....、$7\mu F$

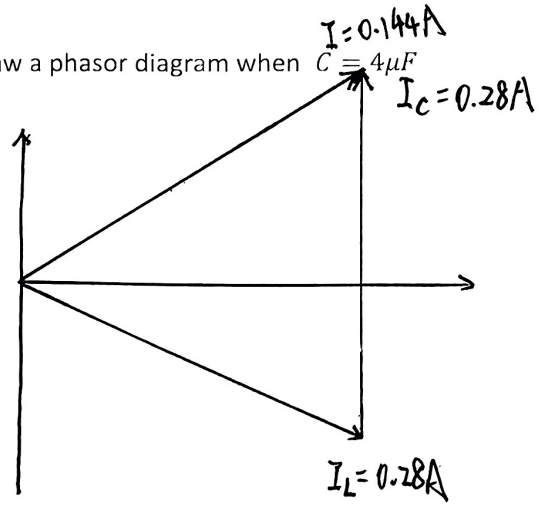
Table 5.8.2 Instructive load parallel with capacitor

$C/\mu F$	1	2	3	3.7	4	4.7	5	6	7
I/A	0.225	0.178	0.144	0.149	0.144	0.173	0.177	0.222	0.283
I_L $/A$	0.281	0.281	0.280	0.280	0.280	0.280	0.280	0.280	0.280
I_C/A	0.0728	0.137	0.210	0.261	0.280	0.333	0.353	0.417	0.490
P/W	27.3	27.5	27.3	30.2	27.5	30.1	27.7	27.6	27.6
$cos\phi$	0.552	0.700	0.862		0.868		0.711	0.565	0.442
ϕ	0.987	0.796	0.532		0.520		0.779	0.970	1.113

Draw curves $cos\phi$—C、I—C

后附

Draw a phasor diagram when $C=4\mu F$



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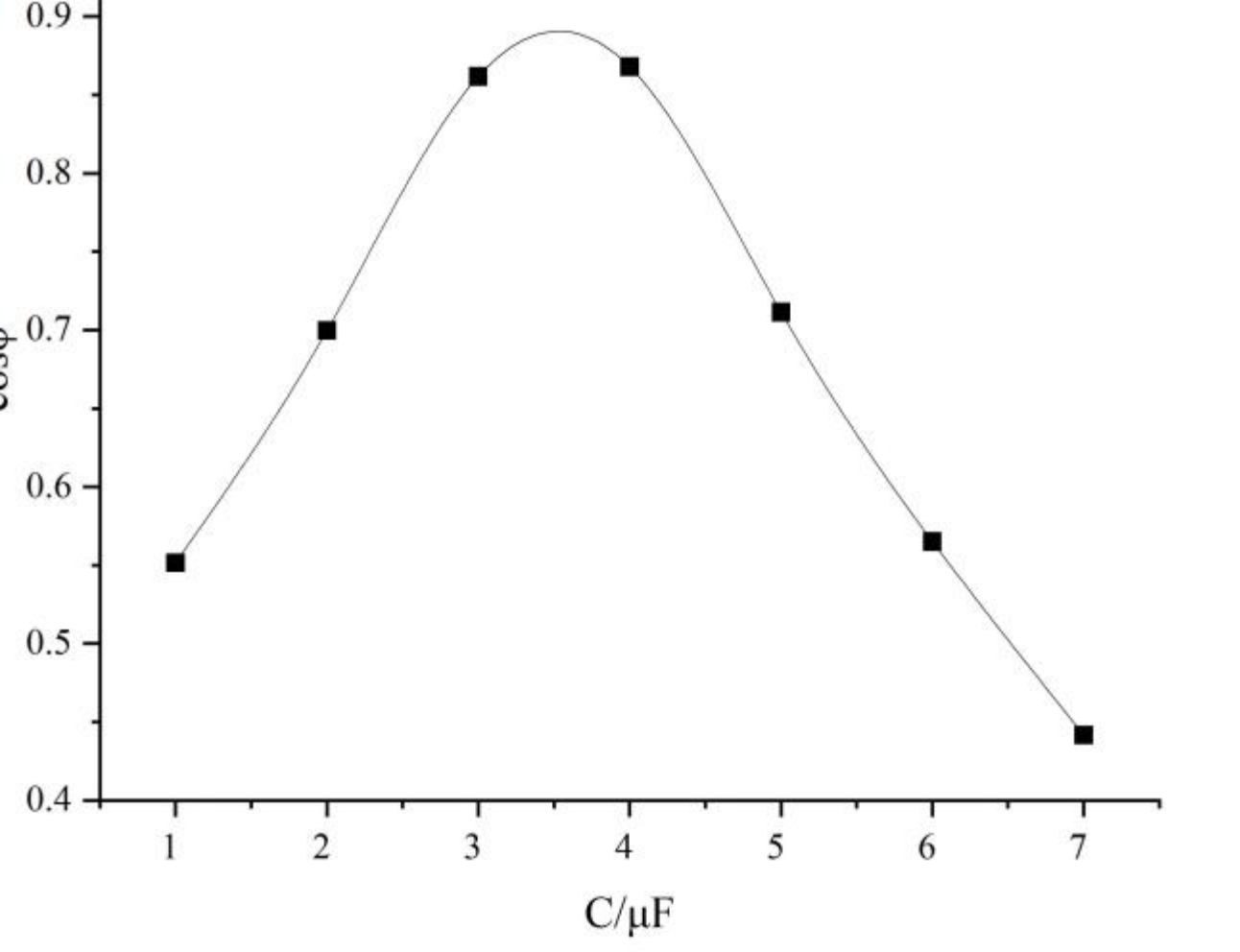
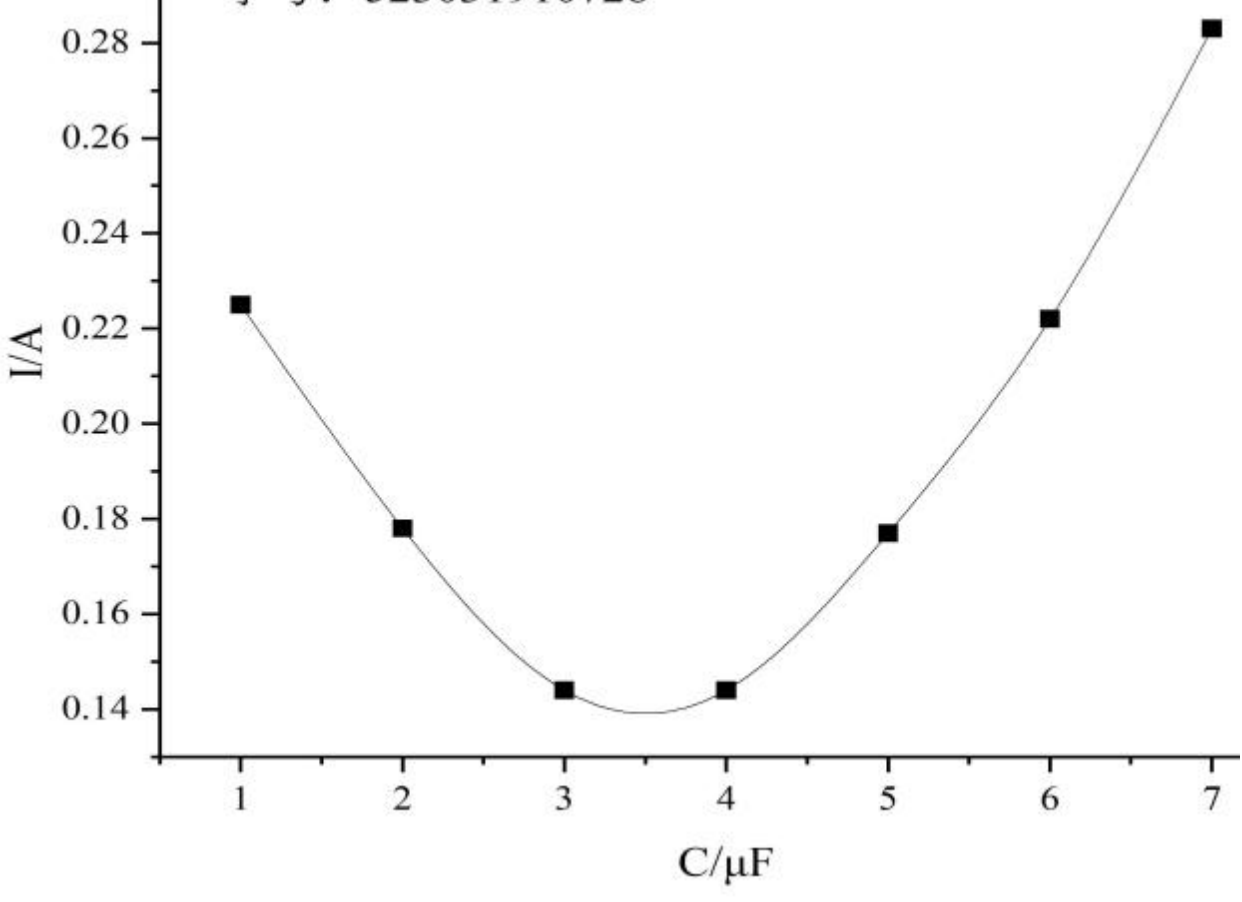

0.9
0.8
0.7
0.6
0.5
0.4
cosφ
1
2
3
4
5
6
7
C/μF


0.28
0.26
0.24
I/A
0.22
0.20
0.18
0.16
0.14
1
2
3
4
5
6
7
C/μF