Universiti Malaysia PAHANG
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Lab 1

Thevenin and Norton's Theorems (AC)

BTE2132
Electrical Fundamentals and Circuit Analysis II Lab

Lab Objectives

By the end of this lab, students should be able to:

1. Calculate the Thevenin and Norton equivalents of an ac circuit.
2. Measure the Thevenin (open circuit) voltage and the Norton (short circuit) current of an ac circuit.
3. Calculate the Thevenin impedance of a circuit using the measured values of Thevenin voltage and Norton current.
4. Measure the load impedance which results in a maximum transfer of power to the load.

Student names	Student ID	Section	Group

Due Date:

Delivery Date:

EQUIPMENT REQUIRED

A. Dual trace oscilloscope
B. Signal generator (sinusoidal function generator)
C. Digital multimeter (DMM)

COMPONENTS

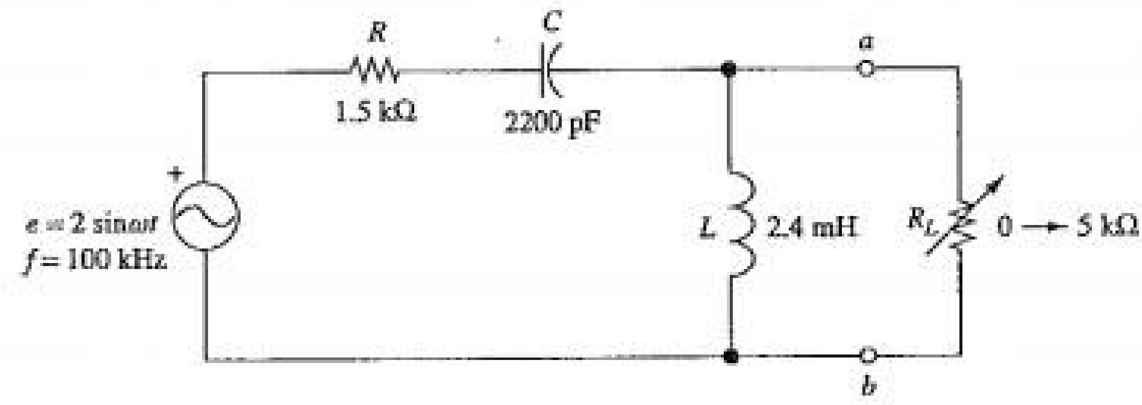
A. Resistors :10 Ω, 1.5 kΩ (1/4 W carbon, 5% tolerance) 5 kΩ variable resistor
B. Capacitors : 2.2 nF (10% tolerance)
C. Inductors :2.4 mH (iron core, 5% tolerance)

EXPERIMENT

1. Refer to the circuit of figure 2-2. Calculate the reactances of the capacitor and the inductor at a frequency of f= 100kHz. Enter the results in Table 1 below

X_C	
X_L	

2. Convert the time-domain form of the voltage source in Figure into its equivalent phasor-domain form and enter the result here.
3. Convert the time-domain form of the voltage source in Figure into its equivalent phasor-domain form and enter the result here.



3. Determine the Thevenin equivalent circuit to the left of terminal a and b in the circuit of Figure 2-2. Sketch the equivalent circuit in this space.
4. Determine the Norton equivalent circuit to the left of terminal a and b in the circuit of Figure 2-2. Sketch the equivalent circuit in this space.
5. Absolute maximum power will be delivered to the load impedance when the load is the complex conjugate of the Thevenin (or Norton) impedance. For that value of load impedance Z_L will the circuit of Figure 2-2 transfer maximum power to the load? Solve for the absolute maximum load power. Enter the results in Table 2

6. Assemble the circuit of Figure 2-2, temporarily omitting the load resistor R_L. Connect Ch1 of the Oscilloscope to the output of the signal generator and adjust the generator to provide an output of 2.0 V_P (4.0 V_{p-p}) at f = 100 kHz.
7. While using Ch1 as the trigger source of the oscilloscope, connect Ch2 between terminals a and b of the circuit. Measure and record the peak-to peak value of the open-circuit voltage amplitude E_{TH} and the phase shift. (The phase shift is measured with respect to the generator voltage observed on Ch1). Enter the result in Table 3.

8. Assemble the circuit of Figure 2-2, temporarily omitting the load resistor R_L. Connect Ch1 of the Oscilloscope to the output of the signal generator and adjust the generator to provide an output of 2.0 V_P (4.0 V_{p-p}) at f = 100 kHz.
9. While using Ch1 as the trigger source of the oscilloscope, connect Ch2 between terminals a and b of the circuit. Measure and record the peak-to peak value of the open-circuit voltage amplitude E_{TH} and the phase shift. (The phase shift is measured with respect to the generator voltage observed on Ch1). Enter the result in Table 4

E_{TH}	V_{P-P}
P_{max}	

10. Place a 10 Ω sensing resistor between terminal a and b. The sensing resistor has a very low impedance with respect to the other components in the circuit and so has a minimal loading effect. Readjust the generator voltage to ensure that the output is 2.0 V_P. Measure the peak-to-peak voltage across the sensing resistor and determine the peak-to-peak value of the 'short circit' current I_N and the phase shift ϴ. Enter the results in Table 5

11. Use the DMM to adjust the 5 kΩ variable resistor for a resistance of 500 Ω. Remove the sensing resistor and insert the variable resistor between terminals a and b of the circuit. Adjust the supply voltage for 2.0 V_{P_P} and measure the amplitude of the output voltage V_L. Enter your measurement in Table 2-5.
12. Remove R_L from the circuit and incrementally increase the resistance by 500 Ω. Repeat step 8. Keep increasing the load resistance until R_L = 5 kΩ. Enter all data in Table 6

R_L	V_L	
500 Ω		
1000 Ω		
1500 Ω		
2000 Ω		
2500 Ω		
3000 Ω		
3500 Ω		
4000 Ω		
4500 Ω		
5000 Ω		

Table 6

DISCUSSION

11. Convert the measured voltage and phase angle for the Thevenin voltage of Step 7 into its correct phasor form. Record your result in the space provided below. How does this value compare to the theoretical value determined in Step 3?

E_{Th}	

12. Convert the measured current and phase angle for the Norton current of Step 8 into its correct phasor form. Enter the result below. How does this value compare to the theoretical value determined in Step 4?

E_{Th}	

13. Use the data of Table 5 to calculate the power delivered to the load for each of the resistor values. (Remember that you will need to convert each voltage measurement into its equivalent rms value in order to calculate the power). Enter the results in Table 6.

R_L	P_L
500 Ω	
1000 Ω	
1500 Ω	
2000 Ω	
2500 Ω	
3000 Ω	
3500 Ω	
4000 Ω	
4500 Ω	
5000 Ω	

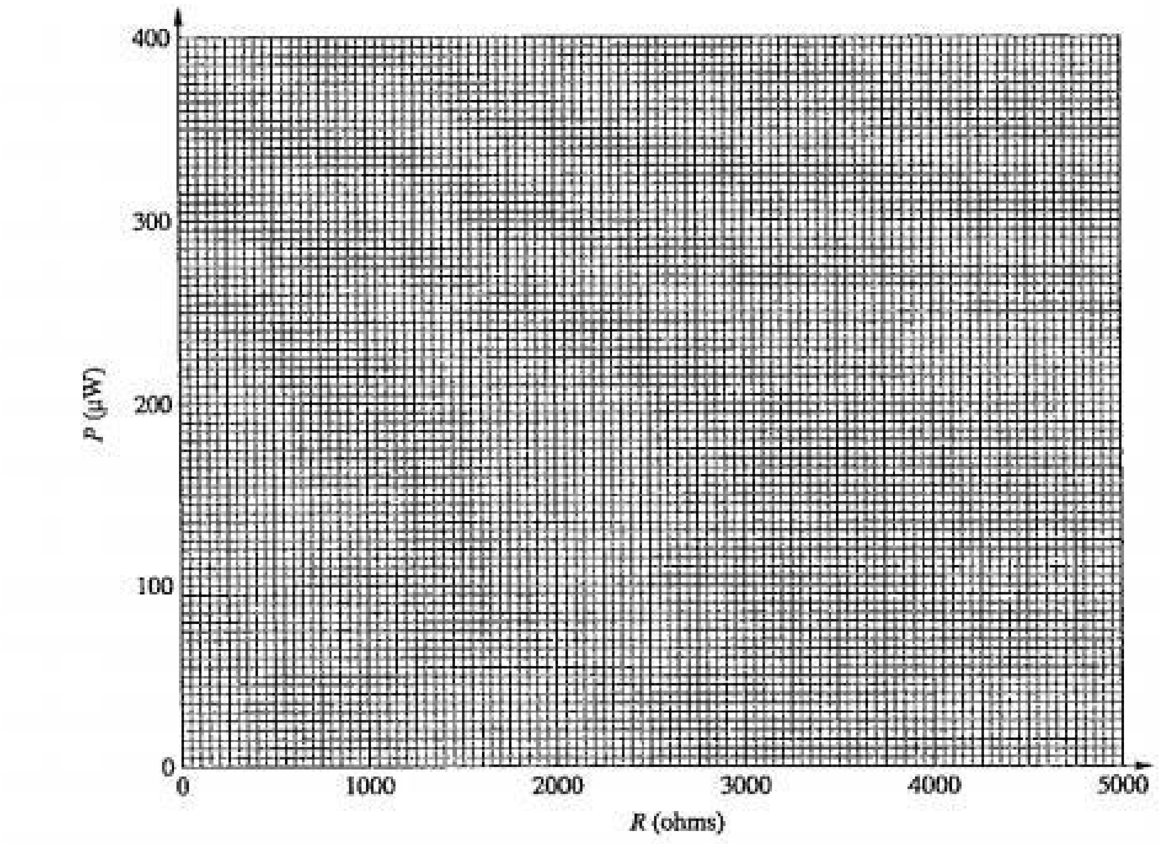
Table 6

14. Use the data of Table 6 to sketch a graph of power (in µWatts) versus load resistance (Ω). Connect the points with the best smooth, continuous curve.

15. Use the curve of Graph 1 to determine the approximate value of load resistance R_L for which the load receives maximum power from the circuit. Enter the result here.

R_L	

GRAPH 1



Signature of instructor: ………………………………..

Date: ………………………………