

Lab 10: Power Calculation

OBJECTIVE:

- You will learn how to calculate the real power, reactive power, and apparent power of a simple RC circuit.

BACKGROUND

You know by now that power in AC circuits is generally a complex quantity. Assume that the source is an AC and the load resistance is Z

$$S = P + jQ$$

Where S is the complex power, P is the real power, and Q is the reactive power.

If the current and voltage in a load are $i(t)$ and $v(t)$, then

The instantaneous power $p(t)$ is defined as

$$p(t) = v(t) \cdot i(t)$$

Assume that the current and voltages are sinusoidal

$$v(t) = V_m \cos(\omega t + \theta_V)$$

$$i(t) = I_m \cos(\omega t + \theta_I)$$

Then, the instantaneous power is

$$p(t) = V_m \cos(\omega t + \theta_V) \cdot I_m \cos(\omega t + \theta_I)$$

$$p(t) = \frac{V_m I_m}{2} [\cos(\theta_V - \theta_I) + \cos(2\omega t + \theta_V - \theta_I)]$$

The first term is constant and does not depend on time, the second is sinusoidal with double frequency. The average power is the total energy in a cycle divided by the cycle time

$$P = \frac{V_m I_m}{2} \cos(\theta_V - \theta_I)$$

In phasor format, the calculation is as follows

$$\bar{S} = \bar{V} \bar{I}^*$$

$$\bar{S} = (V_{rms} \angle \theta_V)(I_{rms} \angle -\theta_I)$$

$$\bar{S} = V_{rms} I_{rms} \angle (\theta_V - \theta_I)$$

$$\bar{S} = V_{rms} I_{rms} \cos(\theta_V - \theta_I) + jV_{rms} I_{rms} \sin(\theta_V - \theta_I)$$

Where the first term is the average power (active power) in Watts, and the second term is the reactive power in VAR.

PRELAB

In the circuit show below, find the current flowing from the source and the voltage across the load.

Calculate the average power, reactive power, and complex power at the load. Assume the frequency is 60 Hz.

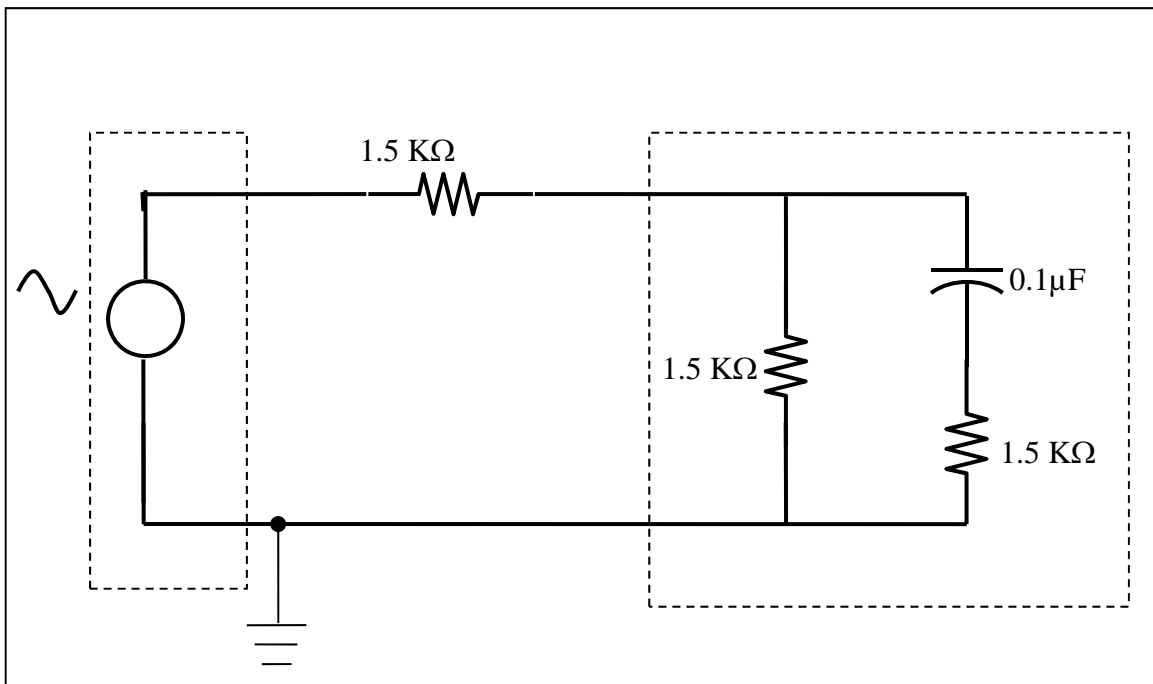


Figure L10.1 A simple AC circuit

LAB

Consider the following Circuit.

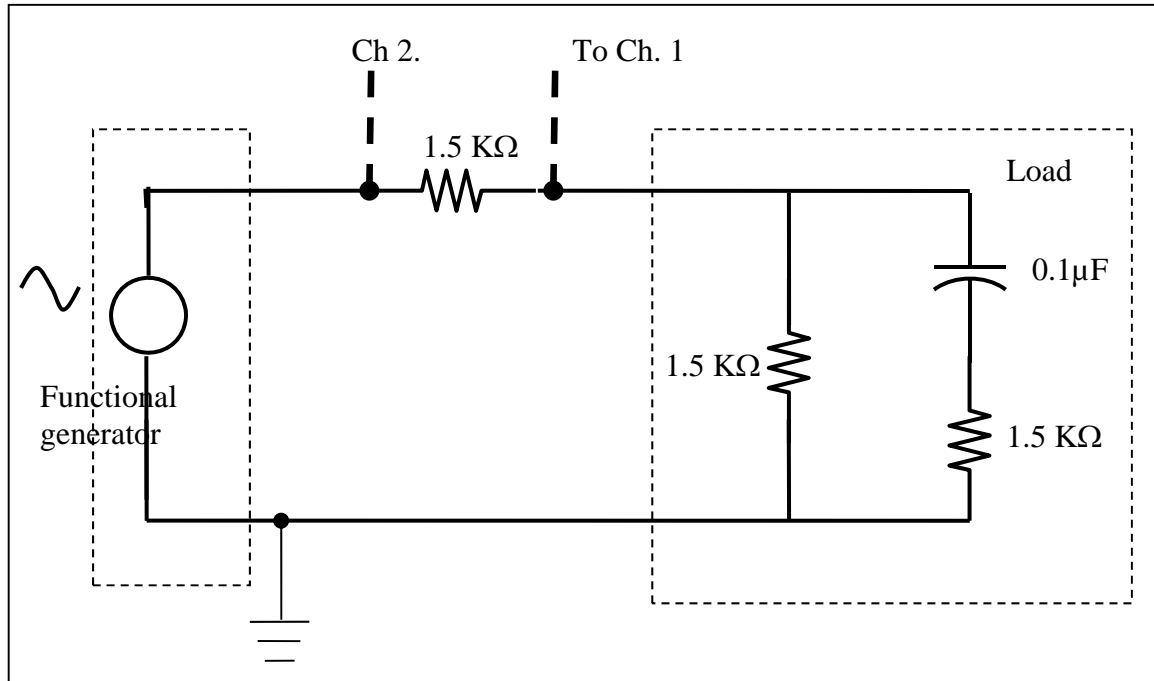


Figure L10.2 The previous circuit showing the connection to the scope.

Construct the above circuit in the lab.

Set the function generator to produce 10V P-P sine wave with a frequency of 60 Hz.

Measure the actual values for the resistors.

Then you have to calculate the actual power at the load (active and reactive).

In order to calculate the power, you need to know the current and voltage at the load.

Connect V_a and V_b to the two channels of the oscilloscope.

Adjust the vertical position of the display such that each signal goes the same value above and below the center line (in other words, make the zero values of the signal at the same vertical position).

V_a will clearly give you the voltage across the load, but what about V_b ? V_b measures the voltage across the source. We know from KVL

$$V_S = V_R + V_{Load}$$

By knowing V_S and V_{Load} , you can calculate V_R . V_R is the voltage across a resistive load, which means the current in the resistor I_R is

$$I_R = \frac{V_R}{R}$$

Basically V_R is a scaled version of I_R , which could be calculated easily. I_R is the same as I_{Load} .

Knowing measured I_{Load} and V_{Load}

In a table compare between the values you got from solving the circuit in the prelab section with the measured values.