MARMARA UNIVERSITY
FACULTY OF ENGINEERING

PHYS 1104

PHYSICS LABORATORY II

Non-Ohmic Device In A Circuit

Section:
Group:
Instructure: Date:

	Department	Student Id Number	Name & Surname
1			
2			
3			

1 Purpose

To investigate and compare the non-ohmic behavior of a tungsten filament bulb with a resistor which has ohmic characteristic.

2 Theory

According to the Ohm's law, the resistance of a resistor varies linearly as the voltage applied on it increases. This is called as Ohmic behavior and ohmic devices create a straight line on a current versus potential difference (voltage) plot. Since a bulb made with the tungsten filament has a resistance dependence on the temperature, the plot of current versus voltage will be like a parabola for the bulb. Here, the reason of the nonlinear resistance change is arisen from the scattering mechanism in metals which hinders the electron transport. As a result, the resistance of the device increases. Due to the tungsten metal has a large temperature coefficient, the resistance of the filament bulb increases as the filament heats up. If the voltage applied on the bulb increases, the temperature and the brightness of the bulb also increases. Below, the resistance formula is given related to the temperature. Using this formula, one can find the resistance of the bulb at corresponding temperature.

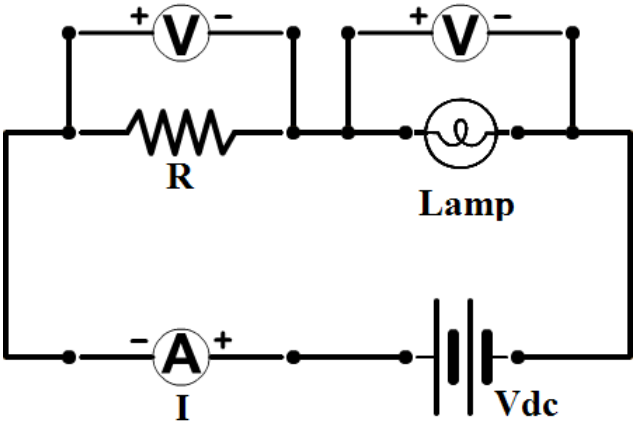

Figure 1: Filament Bulb Circuit

$$R = R_{room}[1 + \alpha(T - T_{room})] \tag{1}$$

Here, the α is the temperature coefficient of the tungsten and T is the temperature in Kelvin for the maximum terminal voltage you apply. T_{room} is 293 K. R_{room} is the resistance of the bulb before the experiment. R is the resistance at maximum terminal voltage.

3 Experimental Setup

3.1 Equipment List

1. Board x1
2. Filamnet bulb x1
3. Resistance x1
4. DC voltage source (0 – 25 V range) x1
5. Digital multimeter x2
6. Connection cables

4 Procedure

1. Build the circuit shown in the Figure 1.
2. Connect a small resistance in series to the bulb. This prevents the heating and burning of the bulb.
3. Apply the DC voltage to the circuit by the power source as the terminal voltage and increase the terminal voltage step by step. For each terminal voltage value, measure and record the potential differences of the resistor and bulb using the digital multimeters.
4. Also measure the current passing through the circuit with the analog ampermeter on the board simultaneously.
5. After filling the Table 1, plot an I-V graph for the bulb and resistor using the data.
6. Measure the resistance of the bulb at room temperature using a multimeter.
7. Assume the temperature of the laboratory is 293 K.
8. Record the maximum voltage occurred on the bulb during the experiment.
9. Calculate the temperature of the tungsten filament using the resistance value you found for maximum voltage. For calculation use the equation 1. Note: Temperature coefficient for tungsten is $4.5\text{x}10^{-3}K^{-1}$.
10. In order to see the nonlinear behavior of the tungsten filament bulb, wait little enough the bulb to heats up.

Table 1: Voltage and current values of the resistor and bulb

	Voltage of Bulb (V)	Voltage of Resistor (V)	Current (A)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

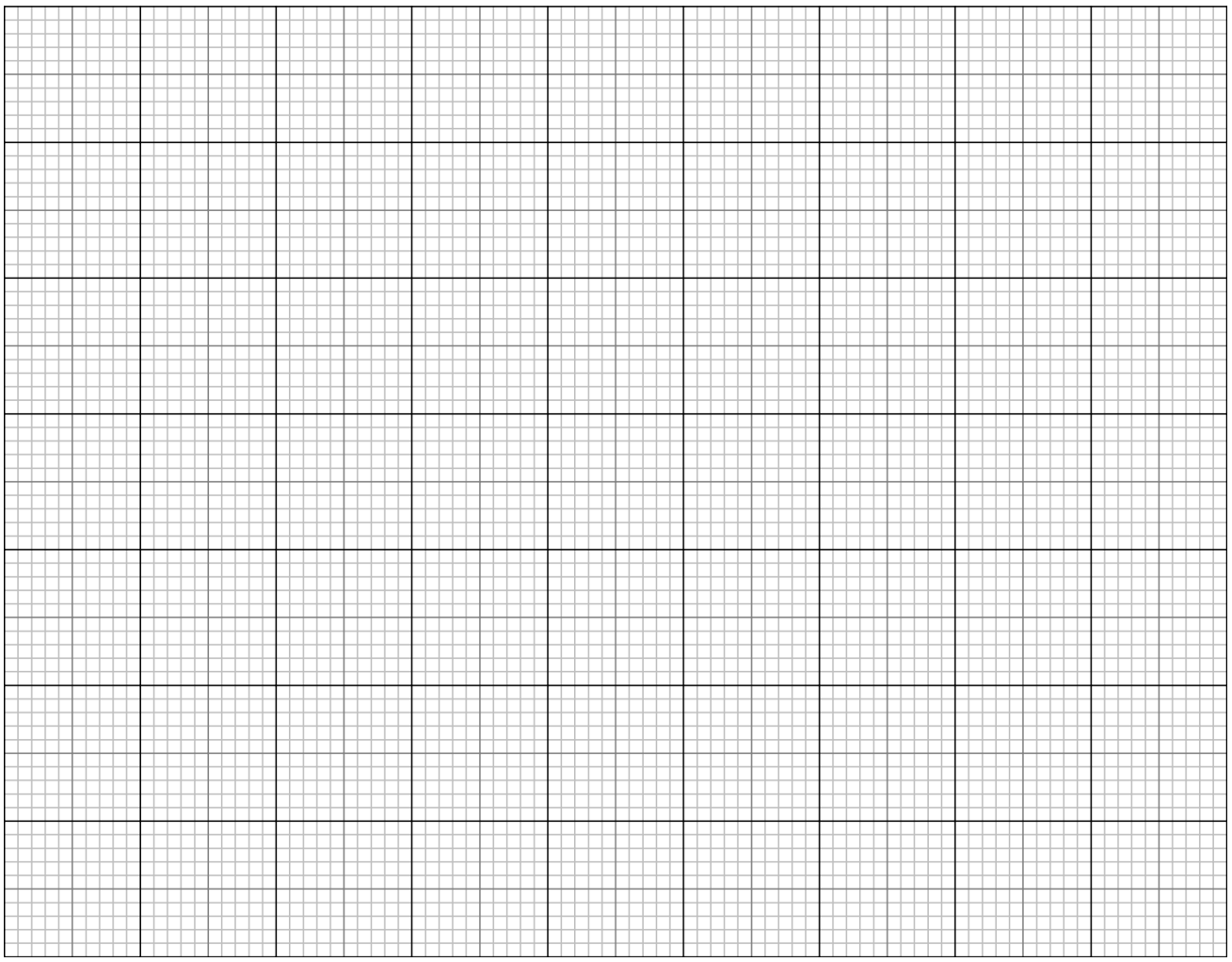

Figure 2: Voltage vs Current graph. (each square unit is 2 mm)