KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

Electrical Engineering Department

EE 208 ELECTRICAL SYSTEMS

Experiment # 5 ELECTRICAL POWER AND ENERGY

OBJECTIVE:

1- To verify the **voltage** – **current** – **power relationship** of electrical devises.

2- To **measure** the **power** consumed by common household electrical appliances. Also, to determine the **cost of operation** per hour at the local power rate.

3- To study the **power** characteristics of a **resistor**.

4- To determine qualitatively the **effect of increased power** dissipation on carbon resistor.

APPARATUS:

DC Power Supply & AC Power Supply
Ohmmeter, DC Voltmeter and DC Ammeter
Digital Power meter
600 W Toaster
60 W Soldering Iron
250 W Electric Hotplate
40 W, 60 W & 100 W Lamp
Carbon Resistors: 470 Ω

THEORY:

The basic relationship between voltage, current, and **power for any electrical** device is determined by

$$\mathbf{P = V\,I} \qquad (1)$$

Then the **Energy** consumed by the device in **KWH** can be found by

$$\textbf{KWH = (Power in Kw) x Hours} \qquad (2)$$

And the cost of the energy consumed by the device can be calculated by

$$\textbf{Total Cost = KWH x rate} \qquad (3)$$

Where "**rate**" is the **cost of 1 KWH** in local currency as prescribed by the power generating company

Now, **if the device is a resistor**, Ohm's law gives the relation between voltage, current & its resistance:

$$V = I\,R \qquad (2)$$

Thus, the power P (in Watts) can be written as follows.

$$\mathbf{P = V\,I = I^2\,R = V^2 / R} \qquad (3)$$

The power **absorbed** by the resistor appears in the form of **heat**. The physical **size** of the resistor determines the **amount** of power that it can safely dissipate. This amount is referred to as the **power rating**. The dissipation of power that exceeds the power rating can **damage** the resistor physically.

When the resistor gets **heated** due to excessive power dissipation, its **resistance changes**. It will either **increase** or **decrease** depending on the **temperature coefficient**. A carbon resistance is expected to **decrease** as the temperature increases.

Resistance that are operated over the power rating will deviate from the straight-line relationship between Voltage and Current. The resistor in this case is operating in the **non-linear region**. In such a case, the **resistance is no longer equal the slope** of the V versus I graphs. It may however, be calculated using the ratio $\mathbf{V}/\mathbf{I}$.

PROCEDURE:

Part I Voltage, Current, Power & Energy Relationship

1- **Connect** the circuit shown in **Figure 1** below.
2- **Choose** the **load** to be as one of those given in **Table 1.**
3- Have your **instructor check** the circuit before connecting the power supply.
4- **Adjust** the AC voltage supply **Vs to 110** V AC.
5- **Measure** the **voltages**, the **currents** and the **power** of the load using the digital power meter.
6- **Record** their values in Table 1.
7- **Repeat** the measurements for the **rest of the loads** given in Table 1.

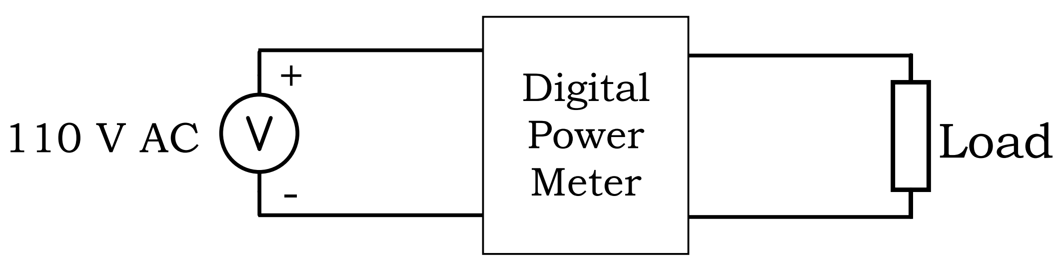

Figure 1

Part II Power Rating Characteristics of Resistors

1- Using an **ohmmeter**, **measure** and **record** the resistance of the resistor supplied.
2- **Connect** the circuit as shown in Figure 2 for R = 470 Ω (1W resistor).
3- **Vary** the input voltage source (**V_s**) from **6 to 24 volts** and measure V and I.
4- **Record** your results in Table 3.

5- As the measurement proceeds, **touch** the resistor from time to time to observe the **temperature rise**.

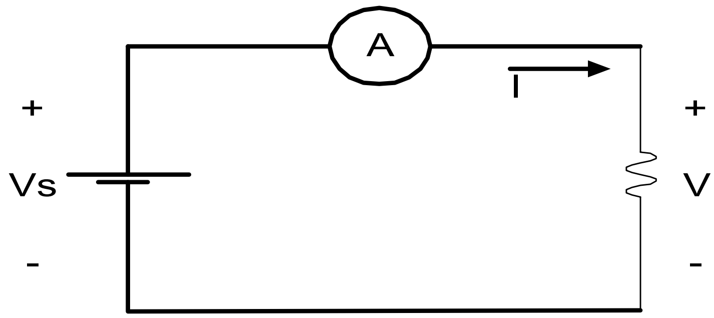

Figure 2

REPORT:

1. **Calculate** the **resistance** and the **power** required by each of the loads and record your results in Table 2.
2. **Calculate** the **kilowatt-hours** used by each of the loads for a **10-hour** period, and also the **cost of operation** at 7 Hallalahs per kilowatt-hour. Record your results in Table 2.
3. For Table 3, **calculate** the **resistance** R (by calculating the ratio V/I) and the **power** dissipated in the resistance (by calculating the product VI).
4. **Plot R versus P** from the calculated data in Table 3. **Comment** on the value of R as P increases.
5. Does the **resistor** in Part II operate in the **linear** region or **non-linear** region? Explain by considering the power rating of the resistor.

QUESTIONS:

1- Is it possible to **purchase** a watt or Kilowatt of power?

2- An electric heater takes **1.48 kW** from a voltage source of **220 V**. **Find** the **resistance** of the heater.

3- If the **current** in a resistor **doubles**, what happens to the dissipated **power**? (Assume the resistor operates in the linear region).

4- A 4 Ω resistor is needed to be used in circuit where the voltage across the resistor is 3V. If two 4 Ω resistors with **1W & 3 W** power rating are available, **which will you use and why**?

EXPERIMENT # 5 Laboratory Report

Name: .... **I.D.** .... **Lab. Section:** ....

TABLE 1

Power Measurement:

Load Name	**Voltage**	**Current**	**Power**
600 W Toaster			
250 W Electric Hotplate			
60 W Soldering Iron			
40 W Lamp			
60 W Lamp			
100 W Lamp			

TABLE 2

Resistance, Power, Energy & Cost Calculation:

Load Name	**Calculated Resistance**	**Calculated Power**	**Calculated KWH**	**Cost for 10 H operation**
600 W Toaster				
250 W Electric Hotplate				
60 W Soldering Iron				
40 W Lamp				
60 W Lamp				
100 W Lamp				

R =

TABLE 3

Power rating: (R = 470 Ω, 1W)

V (volt)	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
I (mA)										
R (Ohm) = V/I										
P (Watt)										