Alexandria University
Faculty of Engineering
Electrical Engineering Department

ECE: Principles and Applications of Electrical Engineering
Sheet 1

1) The capacity of a car battery is usually specified in ampere-hours. A battery rated at, say, 100 A-h should be able to supply 100 A for 1 hour, 50 A for 2 hours, 25 A for 4 hours, 1 A for 100 hours, or any other combination yielding a product of 100 A-h.
   a. How many coulombs of charge should we be able to draw from a fully charged 100 A-h battery?
   b. How many electrons does your answer to part a require?

2) Determine the current through R_3 in Figure 1 for:

   V_S = 12V R_S = 1 kΩ R_1 = 2 kΩ R_2 = 4 kΩ R_3 = 6 kΩ

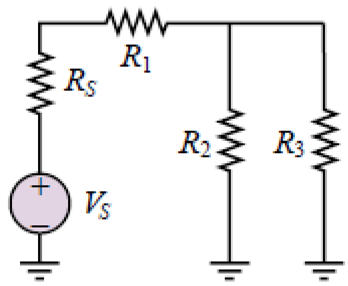


Figure 1

3) If an electric heater requires 23 A at 110 V, determine:
   a. The power is dissipates as heat or other losses.
   b. The energy dissipated by the heater in a 24-hour period.
   c. The cost of the energy if the power company charges at the rate 6 cents/kW-h.

4) Determine which elements in the circuit of Figure 2 are supplying power and which are dissipating power. Also determine the amount of power dissipated and supplied.

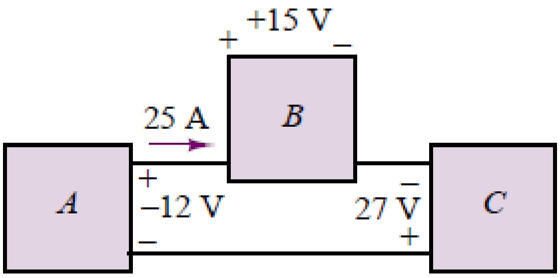
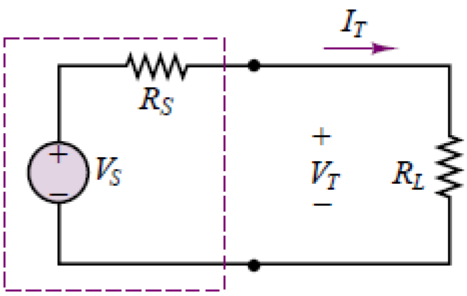


Figure 2

5) In the circuit shown in Figure 3, determine the terminal voltage of the source, the power supplied to the circuit (or load), and the efficiency of the circuit. Assume that the only loss is due to the internal resistance of the source. Efficiency is defined as the ratio of load power to source power.
V_S = 12 V R_S = 5 kΩ R_L = 7 kΩ



Non-Ideal Source

Figure 3

6) For the circuit shown in Figure 4, determine the power absorbed by the 5Ω resistor.

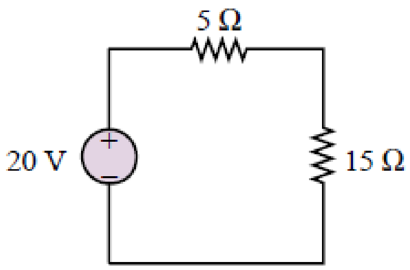


Figure 4

7) With reference to Figure 5, determine:
a. The total power supplied by the ideal source.
b. The power dissipated and lost within the non-ideal source.

c. The power supplied by the source to the circuit as modeled by the load resistance.
d. Plot the terminal voltage and power supplied to the circuit as a function of current.
Calculate for I_T = 0, 5, 10, 20, 30 A.
$V_S = 12$ V $R_S = 0.3\Omega$

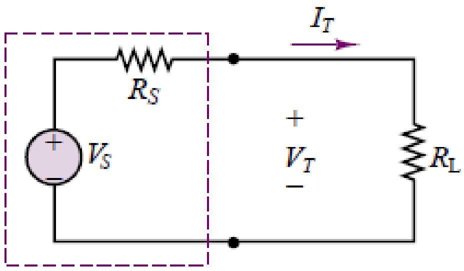


Figure 5

8) In the circuit of Figure 6, if $v_1 = v/8$ and the power delivered by the source is 8 mW, find R, v, v_1, and i.

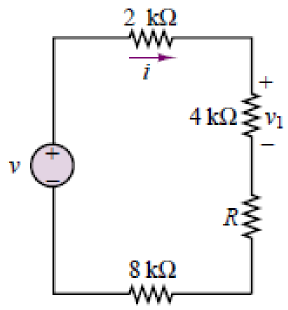


Figure 6

9) An incandescent light bulb rated at 100 W will dissipate 100 W as heat and light when connected across a 110-V ideal voltage source. If three of these bulbs are connected in series across the same source, determine the power each bulb will dissipate.

10) An incandescent light bulb rated at 60 W will dissipate 60 W as heat and light when connected across a 100-V ideal voltage source. A 100-W bulb will dissipate 100 W when connected across the same source. If the bulbs are connected in series across the same source, determine the power that either one of the two bulbs will dissipate.

11) Use Kirchhoff's current law to determine the current in each of the 30Ω resistors in the circuit of Figure 7.

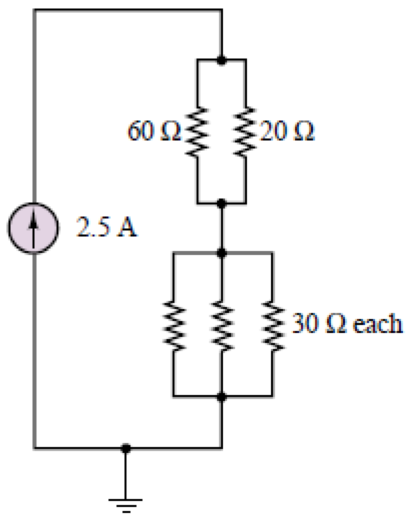


Figure 7

12) The voltage divider network of Figure 8 is expected to provide 2.5 V at the output. The resistors, however, may not be exactly the same; that is, their tolerances are such that the resistances may not be exactly 10 kΩ.

a. If the resistors have ±10 percent tolerance, find the worst-case output voltages.

b. Find these voltages for tolerances of ±5 percent.

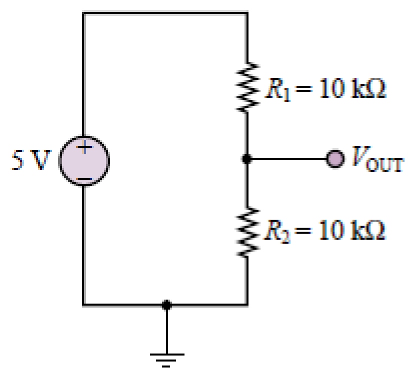


Figure 8

13) For the circuit shown in Figure 9, find

a. The equivalent resistance seen by the source.

b. The current, i.

c. The power delivered by the source.

d. The voltages, v_1, v_2.

e. The minimum power rating required for R_1.

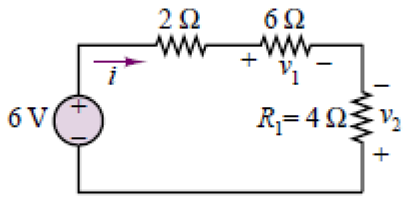


Figure 9

14) Find the equivalent resistance of the circuit of Figure 10 by combining resistors in series and in parallel.

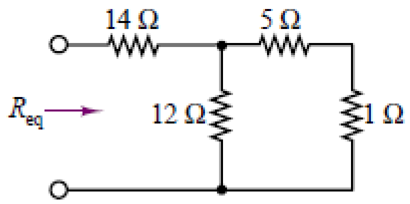


Figure 10

15) Find the equivalent resistance seen by the source and the current i in the circuit of Figure 11.

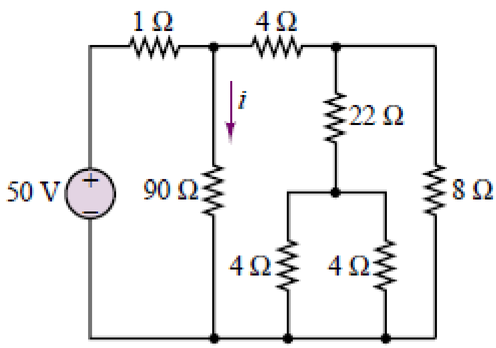


Figure 11

16) In the circuit of Figure 12, the power absorbed by the 15Ω resistor is 15 W. Find R.

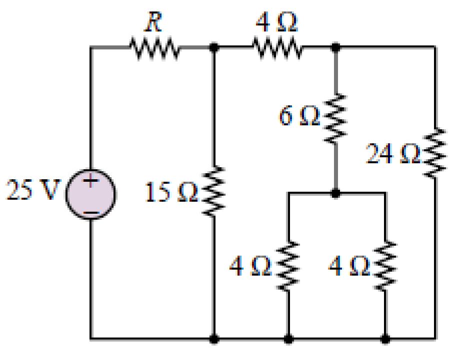


Figure 12

17) Find the equivalent resistance between terminals a and b in the circuit of Figure 13.

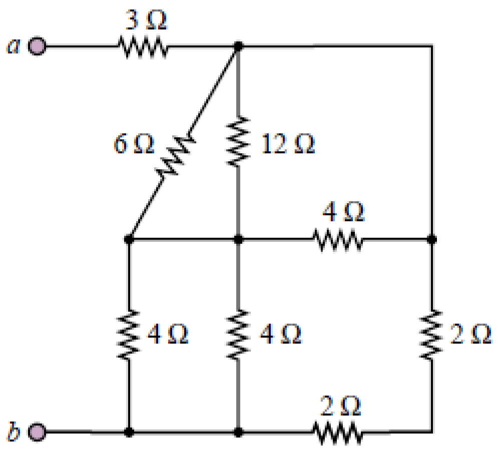


Figure 13

18) For the circuit shown in Figure 14:

a. Find the equivalent resistance seen by the source.

b. How much power is delivered by the source?

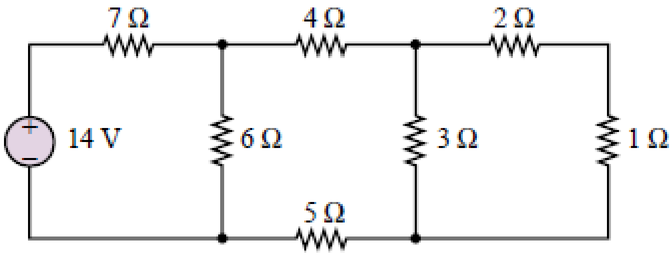


Figure 14

19) In the circuit of Figure 15, find the equivalent resistance looking in at terminals a and b if terminals c and d are open and again if terminals c and d are shorted together. Also, find the equivalent resistance looking in at terminals c and d if terminals a and b are open and if terminals a and b are shorted together.

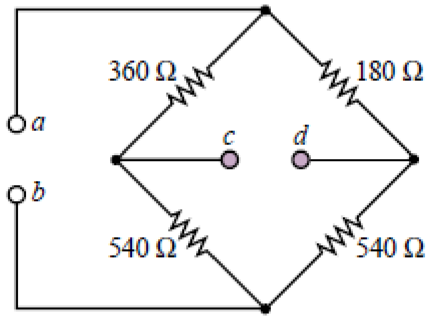


Figure 15

20) Find the currents i_1 and i_2, the power delivered by the 2-A current source and by the 10-V voltage source, and the total power dissipated by the circuit of Figure 16.
$R_1 = 32\ \Omega$, $R_2 = R_3 = 6\ \Omega$, and $R_4 = 50\ \Omega$.

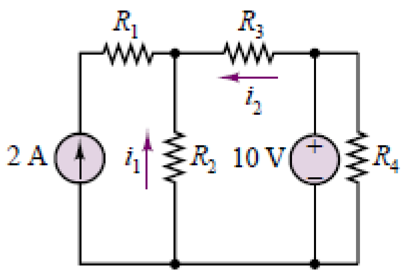


Figure 16

21) Determine the power delivered by the dependent source in the circuit of Figure 17.

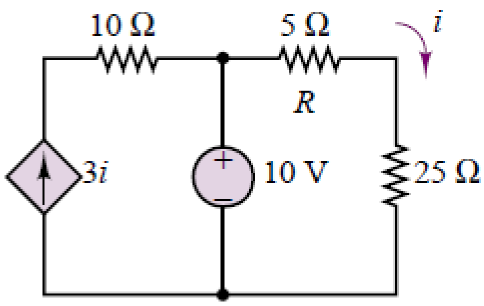


Figure 17

22) Consider the circuit shown in Figure 18.
a. If $V_1 = 10.0$ V, $R_1 = 0.05\ \Omega$, and $R_L = 0.45\ \Omega$, find the load current I_L and the power dissipated by the load.
b. If we connect a second battery in parallel with battery 1 that has voltage $V_2 = 10$ V and $R_2 = 0.1\Omega$, will the load current I_L increase or decrease? Will the power dissipated by the load increase or decrease? By how much?

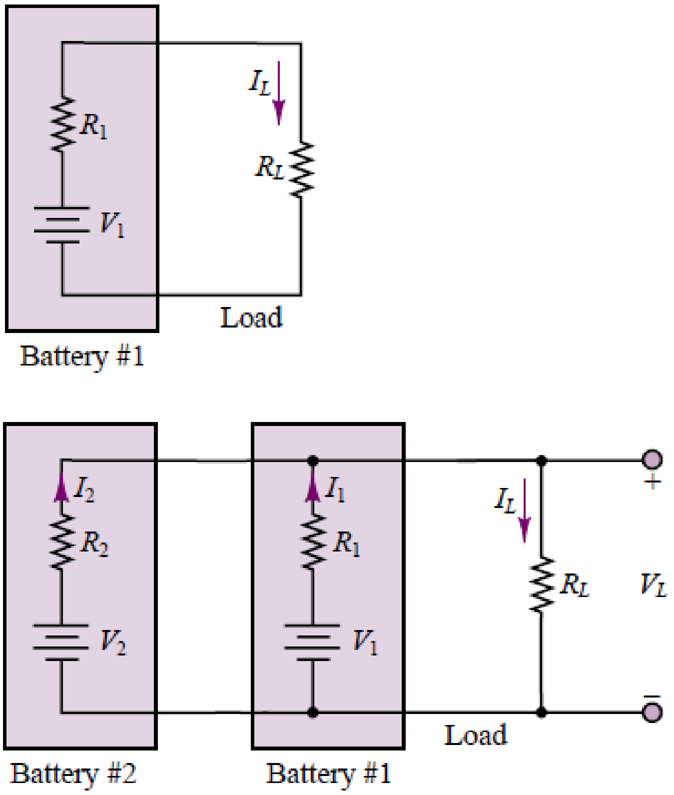


Figure 18

23) With no load attached, the voltage at the terminals of a particular power supply is 25.5 V. When a 5 W load is attached, the voltage drops to 25 V.
a. Determine V_S and R_S for this non-ideal source.
b. What voltage would be measured at the terminals in the presence of a 10Ω load resistor?
c. How much current could be drawn from this power supply under short-circuit conditions?

24) A 120-V electric heater has two heating coils which can be switched such that either can be used independently, or the two can be connected in series or parallel, yielding a total of four possible configurations. If the warmest setting corresponds to 1500-W power dissipation and the coolest corresponds to 200 W, determine:
a. The resistance of each of the two coils.
b. The power dissipation for each of the other two possible arrangements.

25) In the bridge circuit in Figure 19, if nodes (or terminals) C and D are shorted, and:
$R_1 = 2.2$ kΩ $R_2 = 18$ kΩ
$R_3 = 4.7$ kΩ $R_4 = 3.3$ kΩ
determine the equivalent resistance between the nodes or terminals A and B.

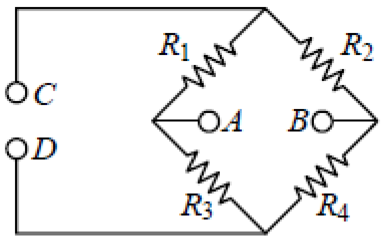


Figure 19

26) Determine the voltage between nodes A and B in the circuit shown in Figure 20.

$V_S = 12$ V $R_1 = 11$ kΩ $R_3 = 6.8$ kΩ $R_2 = 220$ kΩ $R_4 = 0.22$ mΩ

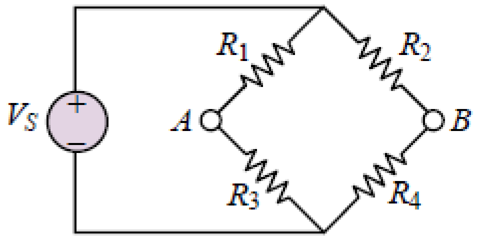


Figure 20

27) Determine the voltage across R_3 in Figure 21.

$V_S = 12$ V $R_1 = 1.7$ mΩ $R_2 = 3$ kΩ $R_3 = 10$ kΩ

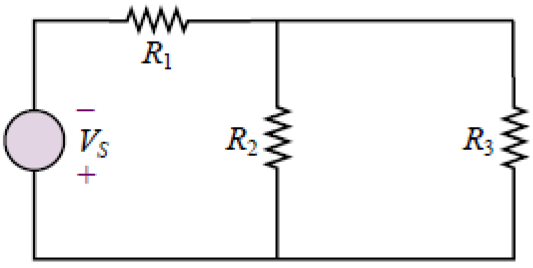


Figure 21

28) A thermistor is a device whose terminal resistance changes with the temperature of its surroundings. Its resistance is an exponential relationship:

$$R_{th}(T) = R_A e^{-\beta T}$$

where R_A is the terminal resistance at T = 0°C and β is a material parameter with units $[°C]^{-1}$.

a. If $R_A = 100$ Ω and $\beta = 0.10/C°$, plot $R_{th}(T)$ versus T for $0 \le T \le 100$°C.

b. The thermistor is placed in parallel with a resistor whose value is 100 Ω.

i. Find an expression for the equivalent resistance.

ii. Plot $R_{eq}(T)$ on the same plot you made in part a.

29) Consider the practical ammeter, diagrammed in Figure 22, consisting of an ideal ammeter in series with a 2-k Ω resistor. The meter sees a full-scale deflection when the current through it is 50μA. If we wished to construct a multirange ammeter reading full-scale values of 1 mA, 10 mA, or 100 mA, depending on the setting of a rotary switch, what should R_1, R_2, and R_3 be?

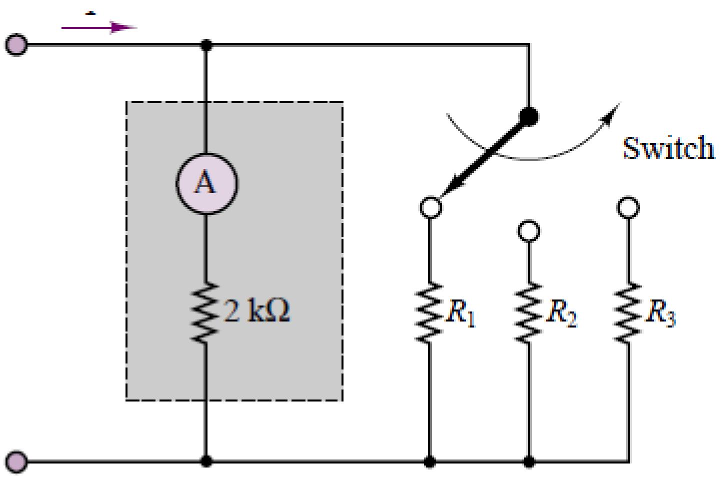


Figure 22

30) Using the circuit of Figure 23, find the voltage that the meter reads if V_S = 10 V and R_S has the following values:

$R_S = 0.1r_m, 0.3r_m, 0.5r_m, r_m, 3r_m, 5r_m$, and $10r_m$.

How large (or small) should the internal resistance of the meter be relative to R_S?

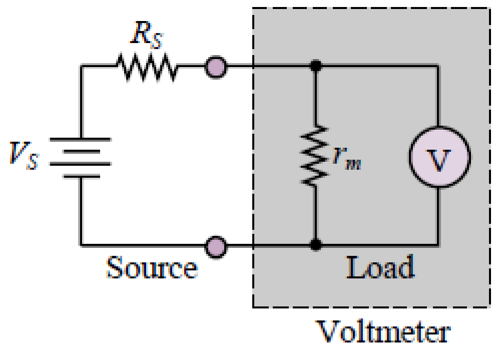


Figure 23