GEORGIA INSTITUTE OF TECHNOLOGY
School of Electrical and Computer Engineering

Course ECE 2040

Circuit Analysis

Assigned: January 12, 2001
Due: January 19, 2001

Problem Set #1

Reading: Read the following sections from the class notes:
Chapter 1, Sections 1.1–1.5

Reading: Some of same topics are discussed in Dorf and Svoboda:
Chapter 1, Sections 1.3–1.5; (definitions of voltage and current)
Chapter 2, Sections 2.5, 2.6; (resistors, sources)
Chapter 3, Sections 3.3; (Kirchoff's Laws)
Chapter 7, Sections 7.3, 7.6; (definitions of capacitors and inductors)

Problem 1.1: (a) The voltage drop across a 1F capacitor is

$$v(t) = \begin{cases} \frac{1}{2}(1 - \cos \pi t), & 0 < t < 2 \\ 0, & \text{otherwise.} \end{cases}$$

This waveform is shown in Figure 1.

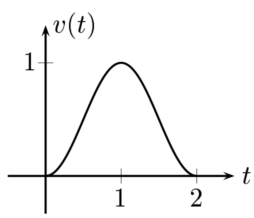

Figure 1: Waveform for Problem 1.6.

(i) Sketch the current flowing through the device, $i(t)$.
(ii) Sketch the energy stored in the device as a function of t.
(iii) For what values of t is the device supplying power?
(iv) For what values of t is the device dissipating power?

(b) Repeat the questions asked in part (a) if $v(t)$ is the voltage drop across a 1H inductor.

Problem 1.2: For the circuit in Figure 2 write a KCL equation at every node in the circuit in terms of the current variables whose reference directions are given.

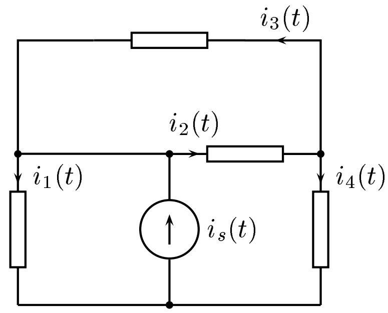

Figure 2: Circuit for Problems 1.7 and 1.13.

Problem 1.3: For the circuit in Figure 3 write a sufficient set of KCL equations in terms of the voltage variables that are labeled. You should incorporate Ohm's Law for the resistors. Exploit any obvious series and parallel connections to reduce the number of equations and variables.

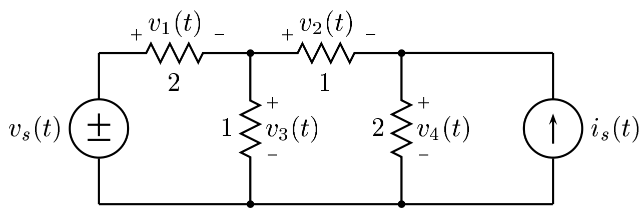

Figure 3: Circuit for Problems 1.9 and 1.21.

Problem 1.4: For the circuit in Figure 4 write a sufficient set of KVL equations to constrain all of the element variables in terms of the current variables that are indicated. You should incorporate Ohm's Law for the resistors. Use any obvious series and parallel connections to reduce the number of equations and variables.

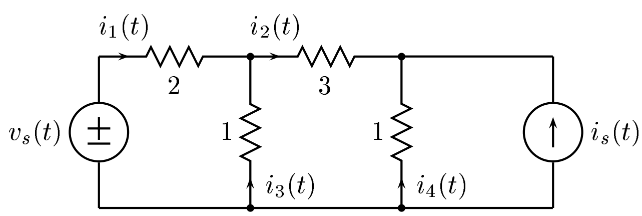

Figure 4: Circuit for Problems 1.14 and 1.22.

Problem 1.5: (a) If a 1kΩ resistor and a 2kΩ resistor are connected in series, which will dissipate more power?

(b) If a 1kΩ resistor and a 2kΩresistor are connected in parallel, which will dissipate more power?

Problem 1.6: Two resistors connected in series act like a single resistor. Similarly, two resistors connected in parallel behave like a single resistor. In this problem, we derive these basic results.

(a) Consider two resistors connected in series and connected across a voltage source, as in Figure 5a. Show that the current flowing through them is proportional to the source voltage.

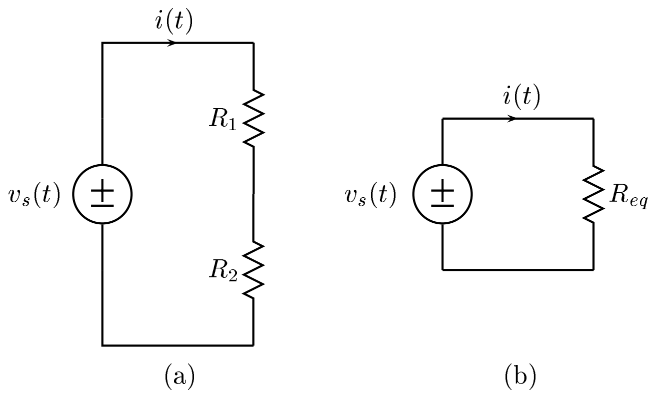

Figure 5: Two resistors connected in series and their equivalent resistance.

(b) This implies that from the point-of-view of the voltage source, the series connection of resistors is equivalent to a single resistor as shown in Figure 5b. Express R_{eq} in terms of R_1 and R_2.

(c) We can similarly consider two resistors connected in parallel across a voltage source, as in Figure 6a. Show again that the current flowing through them is proportional to the source voltage.

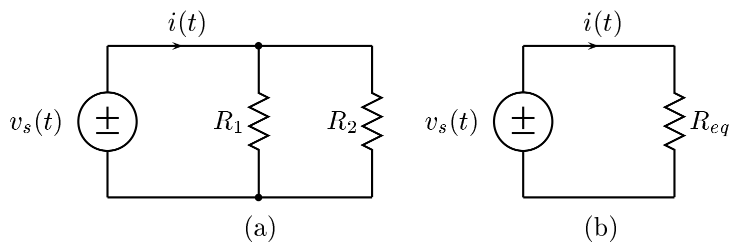

Figure 6: Two resistors connected in parallel and their equivalent resistance.

(d) Find the equivalent resistance of the parallel combination as you did in part (b).