GEORGIA INSTITUTE OF TECHNOLOGY
School of Electrical and Computer Engineering

Course ECE 2040

Circuit Analysis

Assigned: January 26, 2001
Due: Febuary 2, 2001

Problem Set #3

Reading: Read the following sections from the class notes:
Chapter 2, Sections 2.1, 2.3

Reading: Some of same topics are discussed in Dorf and Svoboda:
Chapter 4, Sections 4.3–4.5; (node method)
Chapter 5, Sections 5.4; (superposition of sources)

Problem 3.1: This problem will solve the circuit in Figure 1 using the Simplified Exhaustive Method using both voltage and current variables. In addition to the three voltage variables

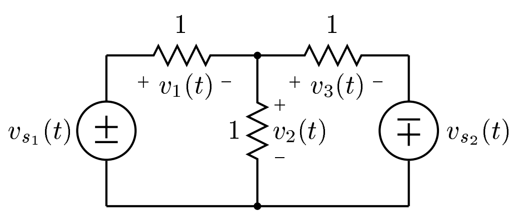

Figure 1: Circuit for Problem 3.1.

that are indicated, define current variables $i_1(t)$, $i_2(t)$, and $i_3(t)$ flowing through the three resistors with reference directions defined according to the default sign conventions. Let $i_1(t)$ be the current through the resistor with voltage drop $v_1(t)$, etc.

(a) Write a sufficient set of KCL equations to constrain the currents. Write these equations in terms of the current variables $i_1(t)$, $i_2(t)$, and $i_3(t)$.

(b) Write a sufficient set of KVL equations to constrain the voltage drops. Write these equations in terms of the voltage variables $v_1(t)$, $v_2(t)$, and $v_3(t)$.

(c) Write the element relations for the three resistors. Write these with both the voltage and current variables on the left-sides of the equations, since these are both element variables.

(d) Put these equations in matrix-vector form. Define the vector of variables as

$$\boldsymbol{x} = \begin{bmatrix} v_1(t) \\ v_2(t) \\ v_3(t) \\ i_1(t) \\ i_2(t) \\ i_3(t) \end{bmatrix}.$$

Solve these equations for the complete set of element variables.

Problem 3.2: (a) For the circuit in Figure 2, what is the minimum number of KCL equations that need to be written to specify the equilibrium solution?

(b) Select one of the nodes of the basic network as the ground node and label it. Define node potentials at the remaining nodes of the basic network and write a KCL equation at each of these nodes in terms of the node potentials (and the source waveforms).

(c) Put your equations in matrix-vector form with the node potentials as unknowns. You do not need to solve the equations.

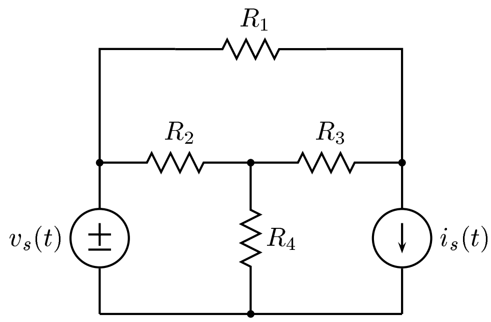

Figure 2: Circuit for Problem 3.2.

Problem 3.3: In this problem we solve the circuit in Figure 3 using the node method.

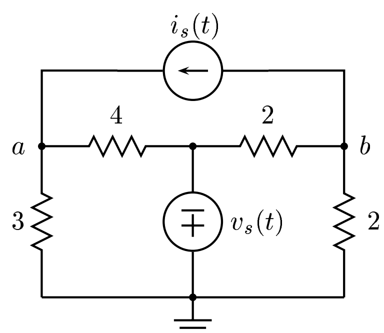

Figure 3: Circuit for Problem 3.3.

(a) Write the KCL equations at nodes a and b in terms of the node potentials at those nodes, $e_a(t)$ and $e_b(t)$.

(b) Put your equations in matrix-vector form by supplying the missing constants in the framework below.

$$\begin{bmatrix} \quad & \quad \\ \quad & \quad \end{bmatrix} \begin{bmatrix} e_a(t) \\ e_b(t) \end{bmatrix} = \begin{bmatrix} \quad \\ \quad \end{bmatrix} i_s(t) + \begin{bmatrix} \quad \\ \quad \end{bmatrix} v_s(t)$$

(c) Solve them for $e_a(t)$ and $e_b(t)$.

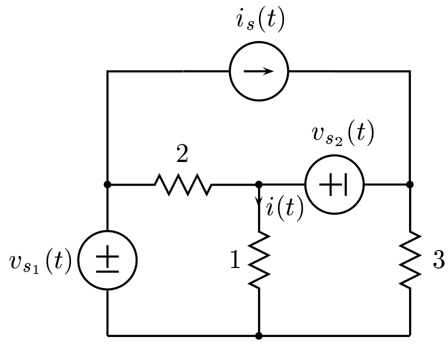

Figure 4: Circuit for Problem 3.4.

Problem 3.4: Solve for $i(t)$ in the circuit in Figure 4.

Problem 3.5: In the circuit in Figure 5

(a) Compute the power supplied by the voltage source. (Note: The power supplied is the negative of the power dissipated.)

(b) Compute the power supplied by the current source.

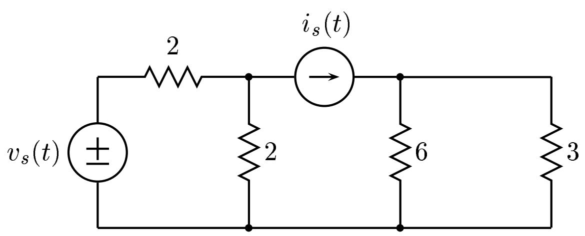

Figure 5: Circuit for Problem 3.5.

Problem 3.6: In the circuit in Figure 6 determine $v(t)$ in terms of $i_s(t)$.

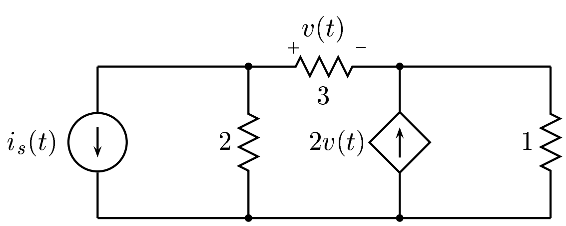

Figure 6: Circuit for Problem 3.6.