GEORGIA INSTITUTE OF TECHNOLOGY
School of Electrical and Computer Engineering

Course ECE 2040

Circuit Analysis

Assigned: February 2, 2001
Due: February 9, 2001

Problem Set #4

Reading: Read the following sections from the class notes:
Chapter 2, Sections 2.4, 2.5
Chapter 3, Sections 3.1
Reading: Some of same topics are discussed in Dorf and Svoboda:
Chapter 4, Sections 4.6–4.8; (mesh method)

Problem 4.1:

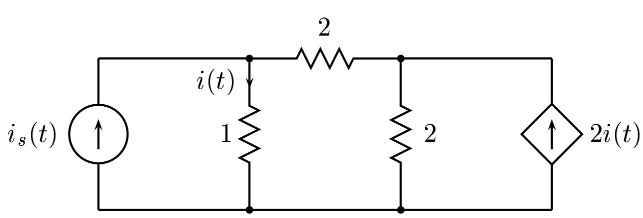

Figure 1: Circuit for Problem 4.1.

(a) For the circuit in Figure 1, what is the minimum number of KVL equations that need to be written to specify the equilibrium solution?

(b) Define a mesh current for each mesh of the basic network. Write a sufficient set of KVL equations in terms of the mesh currents and the source waveforms.

(c) Solve your equations and use the results to determine $i(t)$.

Problem 4.2: Find all of the element voltages and currents in the circuit of Figure 2 using the mesh method. Be sure to identify the variables clearly.

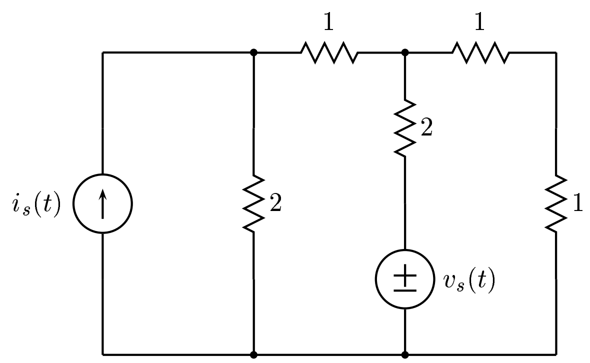

Figure 2: Circuit for Problem 4.2.

Problem 4.3: (a) Which method, the mesh method or the node method, will result in fewer equations to solve in order to determine $v(t)$ in the circuit in Figure 3?

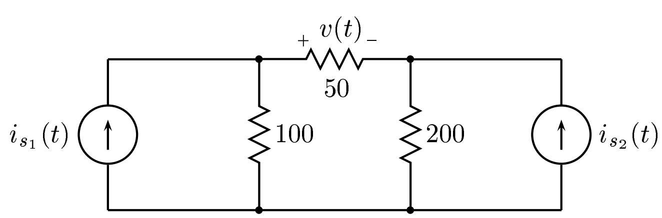

Figure 3: Circuit for Problem 4.3.

(b) Determine $v(t)$ using the method that you selected in (a).

Problem 4.4: Find $v(t)$ in the circuit in Figure 4 by any method that you choose.

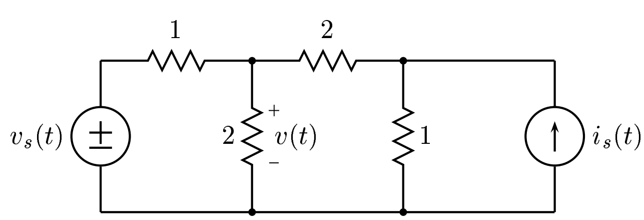

Figure 4: Circuit for Problem 4.4.

Problem 4.5: In our derivation of the mesh method, we stressed its duality with the node method, i.e., the similarity of the two methods if the roles of voltages and currents, and nodes and meshes are reversed. This problem lets you explore this issue further. Consider the network in Figure 5.

(a) Use the node method to determine the set of equations that must be solved to find the equilibrium solution. Omit the ground node when writing your equations. Express these equations in the form

$$\boldsymbol{C}\boldsymbol{v}(t) = \boldsymbol{s}_1 v_{s_1}(t) + \boldsymbol{s}_2 v_{s_2}(t).$$

Here $\boldsymbol{v}(t)$ is a vector of node potentials, $\boldsymbol{s}_1$ and $\boldsymbol{s}_2$ are column vectors of constants, and $\boldsymbol{C}$ is a constant matrix.

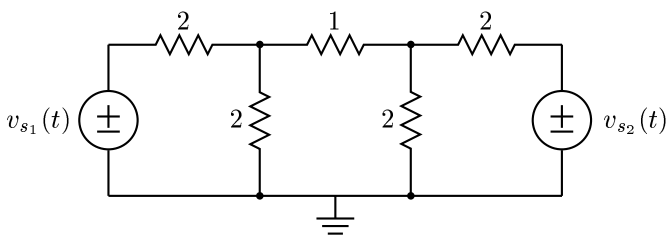

Figure 5: Circuit for Problem 4.5.

(b) Now design a *different* network containing two *current* sources with currents $i_{s_1}(t)$ and $i_{s_2}(t)$, such that the set of *mesh* equations that need to be solved to find the equilibrium solution is

$$\boldsymbol{C}\boldsymbol{i}(t) = \boldsymbol{s}_1 i_{s_1}(t) + \boldsymbol{s}_2 i_{s_2}(t).$$

and $\boldsymbol{i}(t)$ is the vector of mesh currents.

(c) Solve your equations from part (b).

Problem 4.6: Find the $v - i$ relation of the two-terminal network shown in Figure 6.

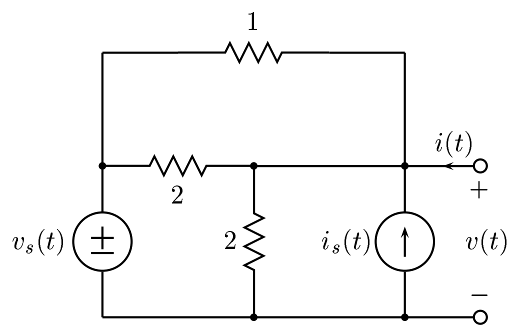

Figure 6: Two-port network for Problem 4.6.