

GEORGIA INSTITUTE OF TECHNOLOGY
School of Electrical and Computer Engineering

Course ECE 2040
Circuit Analysis

Assigned: February 11, 2000

Due: February 18, 2000

Problem Set #5

Reading: Read the following sections from the class notes:

Chapter 3, Sections 3.2

Chapter 4, Sections 4.1,4.2

Reading: Read the following sections from Irwin and Wu:

Chapter 3, Sections 3.3 (operational amplifiers)

Chapter 4, Section 4.4 (Thevenin and Norton equivalents)

Problem 4.1: A network has the $v - i$ characteristic shown graphically in Figure 1.

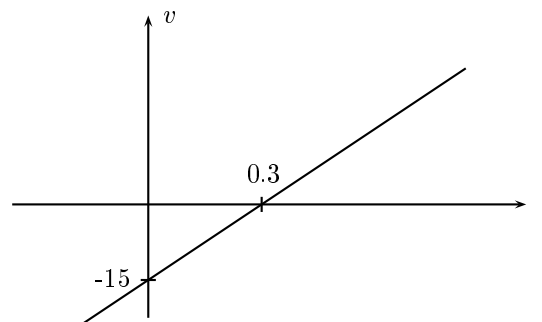


Figure 1: $v - i$ characteristic for Problem 5.1.

- (a) Determine the Thévenin equivalent model corresponding to the network.
- (b) Determine the Norton equivalent model corresponding to the network.

Problem 4.2: Consider the two two-terminal networks N_1 and N_2 shown in Figure 2.

The two networks have the $v - i$ relations

$$N_1 : v_1(t) = 4i_1(t) - 8$$

$$N_2 : v_2(t) = 2i_2(t) + 3.$$

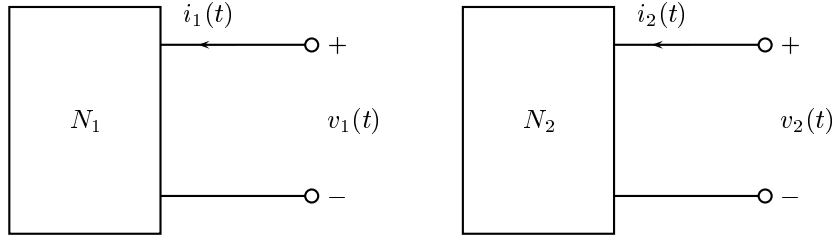


Figure 2: Networks for Problem 5.2

Determine the equilibrium values of $v(t)$ and $i(t)$ if the two networks are connected as shown in Figure 3. *Suggested approach:* Replace each network by its Thévenin equivalent network and then solve the resulting circuit.

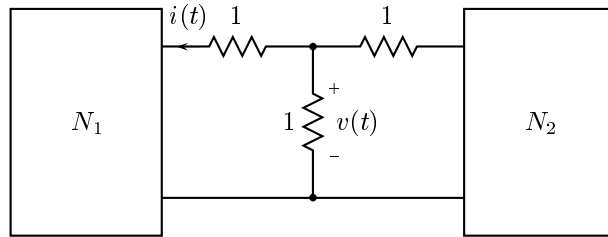


Figure 3: A circuit constructed from the two networks in Figure 2.

Problem 4.3: The two-terminal network N_1 in Figure 4 has the $v - i$ relation

$$v_1(t) = 2i_1(t) - 1$$

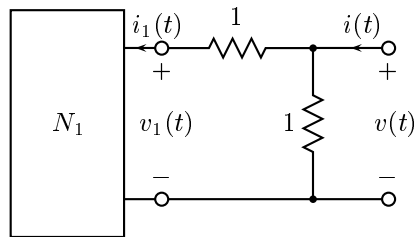


Figure 4: Circuit for Problem 5.3.

- Sketch a two-terminal network that is the Norton equivalent of N_1 .
- Determine $v(t)$ as a function of $i(t)$.

Problem 4.4: A two-terminal network N has the $v - i$ characteristic

$$v_N(t) = 5i_N(t) - 3,$$

where $v_N(t)$ is the voltage drop across the terminals of the network and $i_N(t)$ is the current entering its + terminal. Determine the $v - i$ characteristics of the four two-terminal networks that are constructed from N and shown in Figure 5.

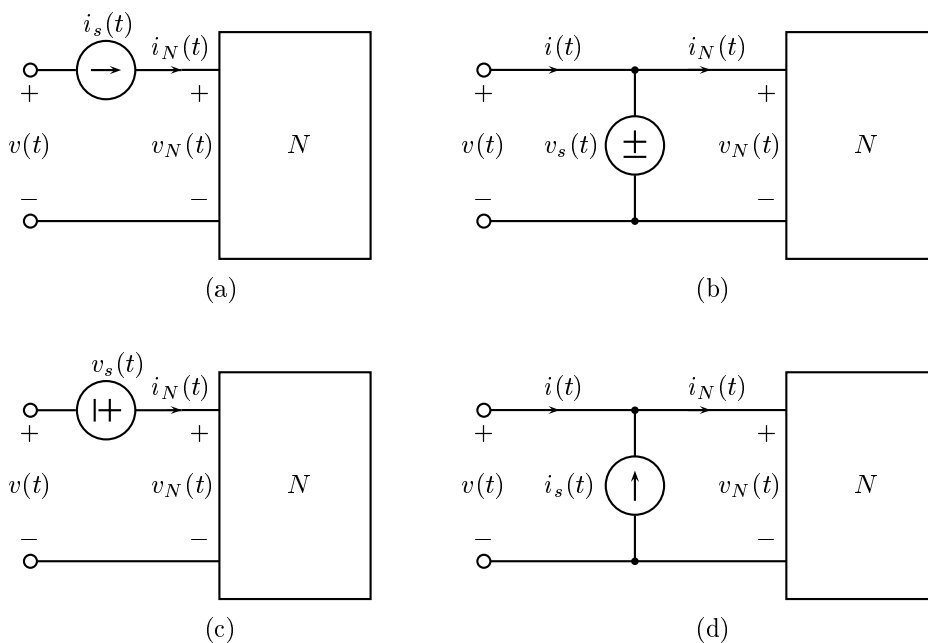


Figure 5: Four circuits constructed from the network N of Problem 5.4 whose $v - i$ relation needs to be determined.

Problem 4.5: For the circuit in Figure 6 do the following:

- Indicate the electric potential at each of the four indicated nodes. For each potential that is unknown prior to analyzing the circuit, give it a symbolic name, such as $e_a(t)$, etc.
- Identify the nodes at which you can write a meaningful KCL equation.
- Determine $v_{out}(t)$ in terms of $v_{in}(t)$.

Problem 4.6: Express the output voltage $v_{out}(t)$ in terms of the input voltage $v_{in}(t)$ for the circuit in Figure 7.

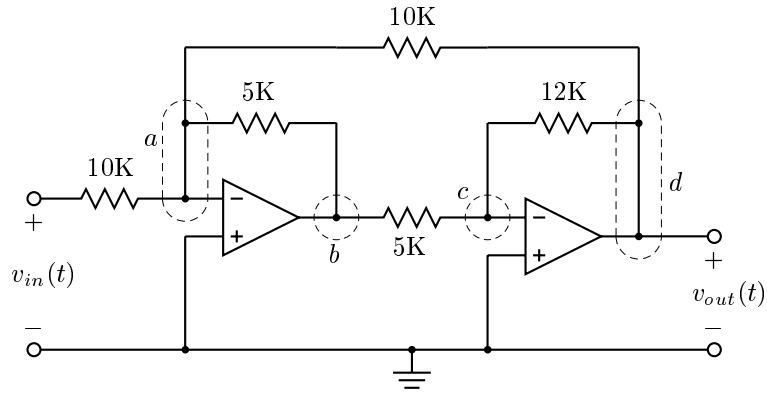


Figure 6: Circuit for Problem 5.5.

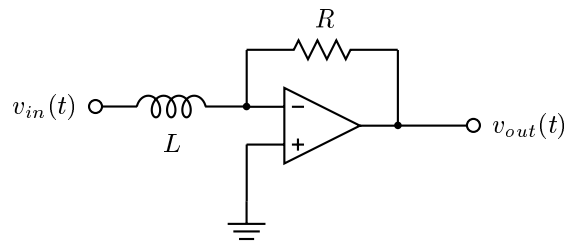


Figure 7: Circuit for Problem 5.6.