

GEORGIA INSTITUTE OF TECHNOLOGY
School of Electrical and Computer Engineering

Course ECE 2040
Circuit Analysis

Assigned: February 9, 2001

Due: February 16, 2001

Problem Set #5

Reading: Read the following sections from the class notes:
Chapter 3, Sections 3.1,3.2

Reading: Some of same topics are discussed in Dorf and Svoboda:
Chapter 3, Sections 3.4–3.7; (resistors in series/parallel)
Chapter 17, Section 17.4; (delta-wye transformation)
Chapter 5, Sections 5.5–5.7 (Thevenin & Norton)

Announcement: Quiz #2 will be held during the class hour on Monday, February 19, 2000. It will be a closed book test, although calculators are permitted. It will cover problem sets 3–5.

Problem 5.1: (a) Determine the equivalent resistance of the two-terminal network in Figure 1a as seen at the terminals $a - a'$.

(b) Repeat for the network in Figure 1b at the terminals $b - b'$.

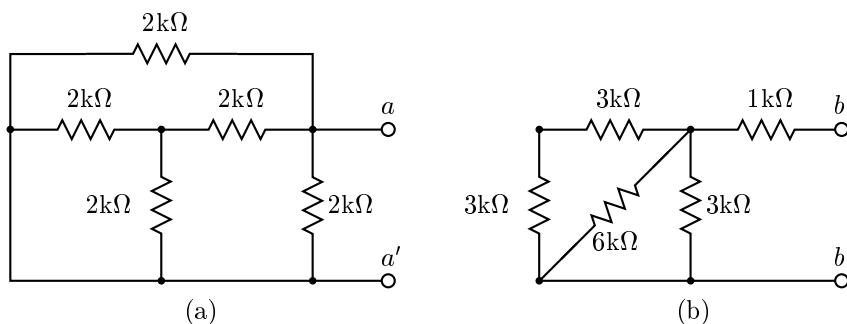


Figure 1: Networks for Problem 5.1.

Problem 5.2: You have a box containing an unlimited number of $10k\Omega$ resistors. Show how to connect some of these together to construct equivalent resistances with the following values:

- (a) $20k\Omega$
- (b) $25k\Omega$

(c) 6667Ω

Problem 5.3: Consider a one-port network consisting of two capacitors with capacitances C_1 and C_2 connected in series, as shown in Figure 2.

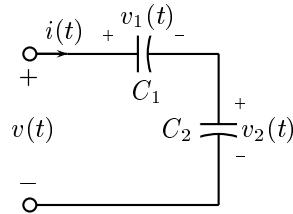


Figure 2: Two capacitors connected in series.

- Show that this network is equivalent to a single capacitor.
- Derive a formula for the equivalent capacitance C_{eq} in terms of C_1 and C_2 .
- Derive expressions for the voltage $v_1(t)$ measured across capacitor C_1 and the voltage $v_2(t)$ measured across C_2 in terms of the voltage $v(t)$ appearing across the series connection.

Problem 5.4: A network has the $v - i$ characteristic shown graphically in Figure 3.

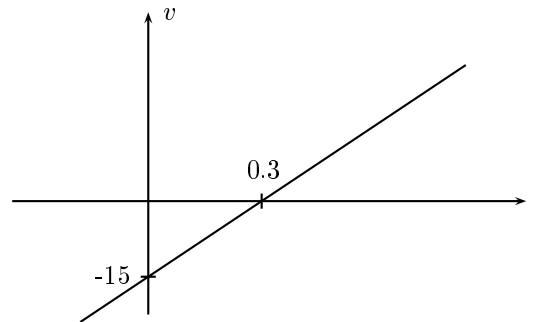


Figure 3: $v - i$ characteristic for the network in Problem 3.9.

- Determine the Thévenin equivalent model corresponding to the network.
- Determine the Norton equivalent model corresponding to the network.

Problem 5.5: Find the equivalent resistance, measured at the terminals, to the two-terminal network in Figure 4.

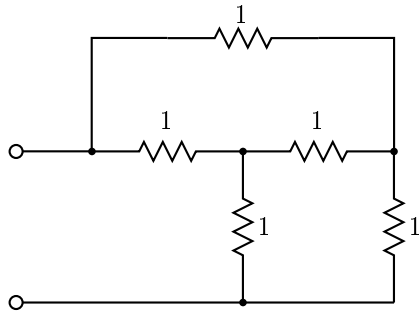


Figure 4: Two-terminal network for Problem 5.5.

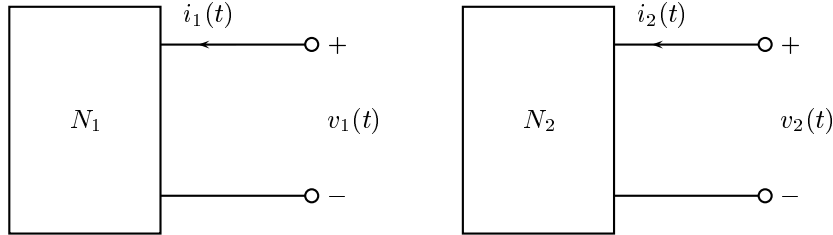


Figure 5: Networks for Problem 5.6.

Problem 5.6: Consider the two two-terminal networks N_1 and N_2 shown in Figure 5.

The two networks have the $v - i$ relations

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

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

Determine the equilibrium values of $v(t)$ and $i(t)$ if the two networks are connected as shown in Figure 6. *Suggested Approach:* Replace each network by its Thévenin equivalent network and then solve the resulting circuit.

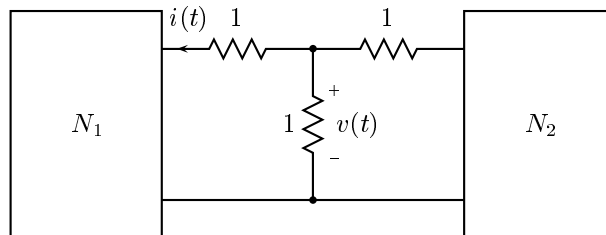


Figure 6: A circuit constructed from the two networks in Figure 5.