GEORGIA INSTITUTE OF TECHNOLOGY
School of Electrical and Computer Engineering

Course EE 2250

Electric Circuit Analysis

January 28, 1999

Problem Set #3—Solutions

Problem 3.1: (a) Show that the network in Figure ?? is equivalent to a single resistor.

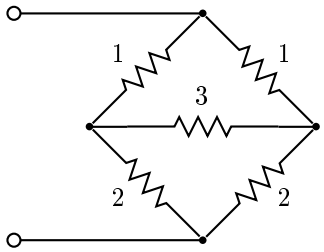


Figure 1:

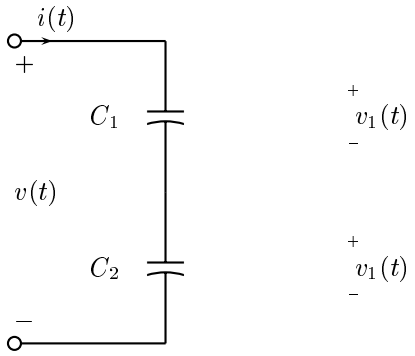
(b) Determine the value of the equivalent resistance, R_{eq}.

Solution:

Problem 3.2: (a) Determine the equivalent resistance of the two-terminal network in Figure ??a as seen at the terminals $a - a'$.

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

Solution:



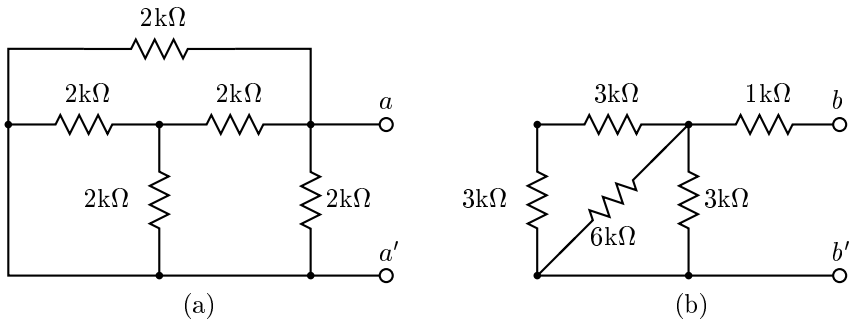


Figure 2:

Problem 3.3: Consider a one-port network consisting of two capacitors with capacitances C_1 and C_2 connected in series.

(a) Show that this network is equivalent to a single capacitor.

(b) Derive a formula for the equivalent capacitance C_{eq} in terms of C_1 and C_2.

(c) 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.

Solution:

Problem 3.4: In an attempt to determine a Thévenin equivalent for a network containing only resistors and sources two experiments are performed. First, a resistor with a value of R ohms is connected across the terminals and the voltage $v_1(t)$ is measured, as shown in Figure **??**. Then a resistor with a value of $2R$ ohms is connected across the terminals and the voltage $v_2(t)$ is measured.

(a) Determine the Thévenin equivalent model for the network in terms of the measured voltages $v_1(t)$ and $v_2(t)$.

(b) What is a good value to choose for R? Explain your answer.

Solution:

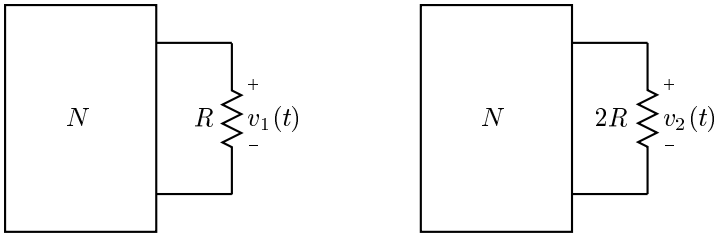


Figure 3:

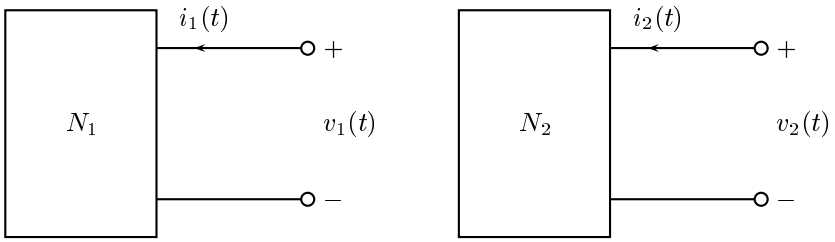


Figure 4:

Problem 3.5: Consider the two two-terminal networks N_1 and N_2 shown in Figure **??**. The two networks have the $v - i$ relations

$$N_1: \quad v_1(t) = 4i_1(t) - 8$$
$$N_2: \quad v_2(t) = 2i_2(t) + 3$$

(a) Determine the equilibrium values of $v(t)$ and $i(t)$ if the two netorks are connected as shown in Figure **??**.

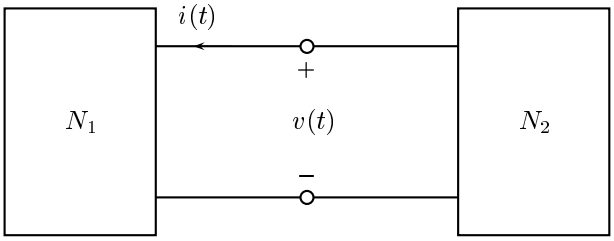


Figure 5:

(b) Repeat part (a) for the connection shown in Figure **??**.

(c) Repeat part (a) for the connection shown in Figure **??**.

Solution:

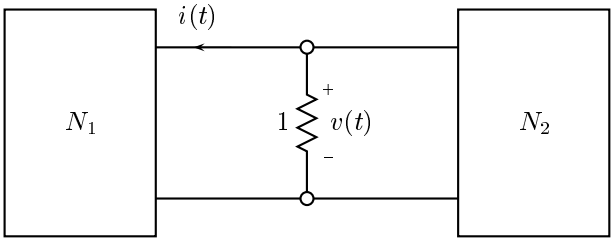


Figure 6:

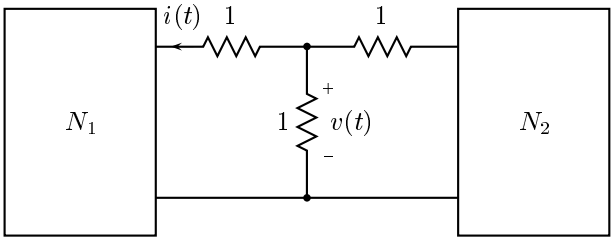


Figure 7:

Problem 3.6: Design a circuit with four inputs $v_1(t)$, $v_2(t)$, $v_3(t)$ and $v_4(t)$ containing a single operational amplifier, such that the output voltage $v_{out}(t)$ satisfies

$$v_{out}(t) = k_5[k_1 v_1(t) + k_2 v_2(t) - k_3 v_3(t) - k_4 v_4(t)]$$

for positive values of the four constants. *Hint:* You might begin by trying to combine features of the differential amplifier configuration and the summing amplifier configuration.

(b) Prove that your design in (a) works correctly.

(c) State any additional constraints that need to be imposed on the four constants.

Solution:
