MASSACHVSETTS INSTITVTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

6.002 – Electronic Circuits
Fall 2001

Problem Set 3

Issued: 20 September 2001 Due: 28 September 2001

Reading:

- A&L Chapter 7 for Thu., 20 Sept. thru Wed., 26 Sept.
- A&L Chapter 8 for Thu., 27 Sept.

Problems:

1. The circuit of Figure 1 below represents the behavior of a common kind of amplifier.

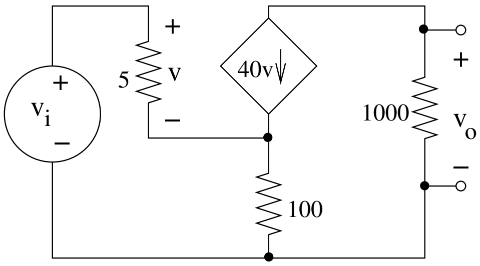

Figure 1: A simple amplifier.

   (a) Determine the output voltage v_0 for a given input voltage v_i. What is the *voltage gain* that you find?
   (b) Construct a Thevenin equivalent circuit for the amplifier, as seen from its output port.

2. Consider the circuits of Figure 2 and Figure 3 below. The two circuits are *port equivalent* if and only if they cannot be distinguished from each other by their behavior when placed into a bigger circuit where each of their ports is connected to an arbitrary one-port circuit. For these two circuits, there are values of the device parameters that make them port equivalent.

   (a) For the circuit of Figure 2, write the equations for the port voltages v_1 and v_2 as functions of the port currents i_1 and i_2.
   (b) For the circuit of Figure 3, write the equations for the port voltages v_1 and v_2 as functions of the port currents i_1 and i_2.

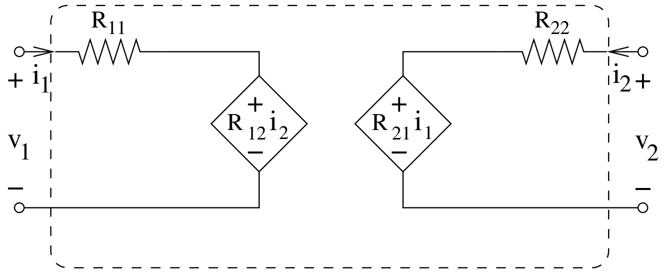

Figure 2: A general two-port circuit.

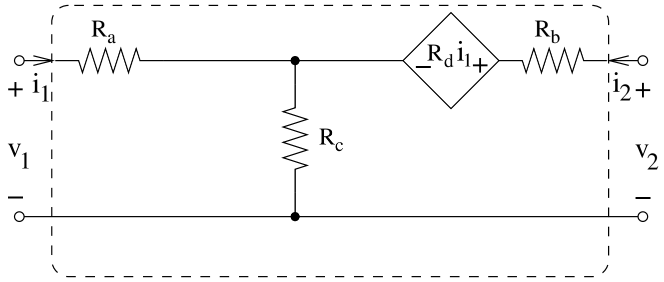

Figure 3: Another two-port circuit.

(c) Determine the values of the device parameters R_a, R_b, R_c, and R_d in terms of R_{11}, R_{12}, R_{21}, and R_{22} such that the two circuits are port equivalent.

(d) Circuits are *terminal equivalent* if they cannot be distinguished by *any* experiment performed at their terminals. For example, Thevenin's and Norton's circuits are terminal equivalent. Are these two circuits terminal equivalent? Justify your answer.

3. For circuits containing only resistors, it turns out that $R_{12} = R_{21}$. This property of resistive networks appears often in physical systems and is called reciprocity. It even applies to two antennas, say antenna A and antenna B. The ratio of open-circuit voltage induced in antenna A to current applied to antenna B is equal to the ratio of open-circuit voltage induced in antenna B to current applied to antenna A! Demonstrate that $R_{12} = R_{21}$ for the network

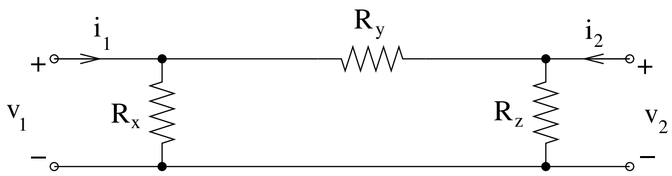

Figure 4: A PI network.

shown in Figure 4.

4. Do Problem 3 from p. 488 of A&L.

5. Do Problem 7 from p. 490 of A&L.