Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.002 – Circuits & Electronics
Spring 2006

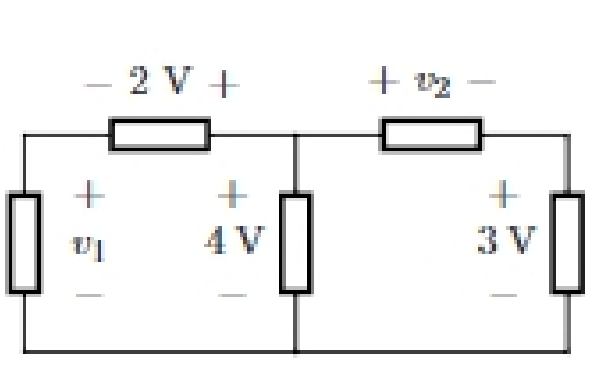
Problem Set #1

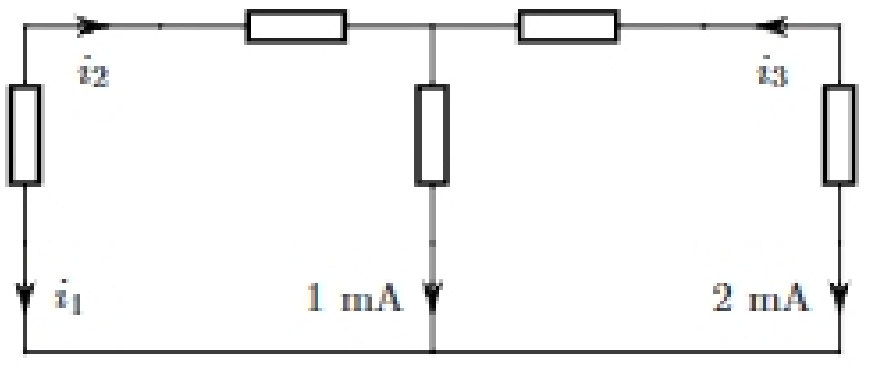
Issued 2/8/06 – Due 2/15/06

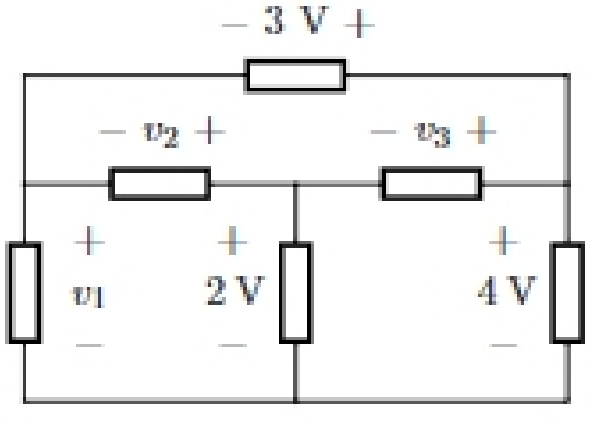
Exercise 1.1: Find the equivalent resistance, as viewed from its port, of each resistor network shown below.

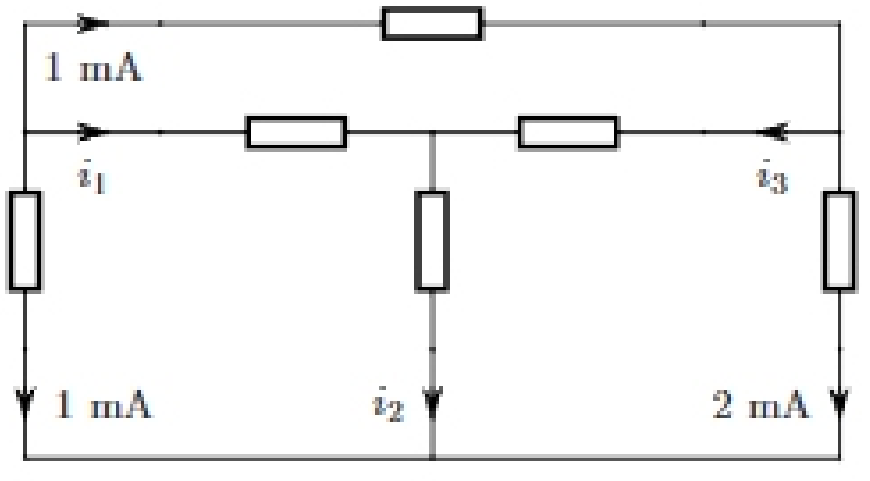
Exercise 1.2: What is the largest-valued resistor that can be fabricated by combining a 1-Ω, a 2-Ω and a 3-Ω resistor? What is the smallest-valued resistor? By combining these three resistors, how can one fabricate a 1.5-Ω resistor?

Problem 1.1: Each network shown below has several of its branch currents or voltages specified numerically. Several other branch currents or voltages are labeled as unknowns. Find all labeled unknown branch currents and voltages.









Problem 1.2: The circuit shown below has four elements: two resistors, a current source and a voltage source. The resistance of the resistors and the strengths of the sources are all given. Branch currents (i_k) and voltages (v_k) are also defined for each element.

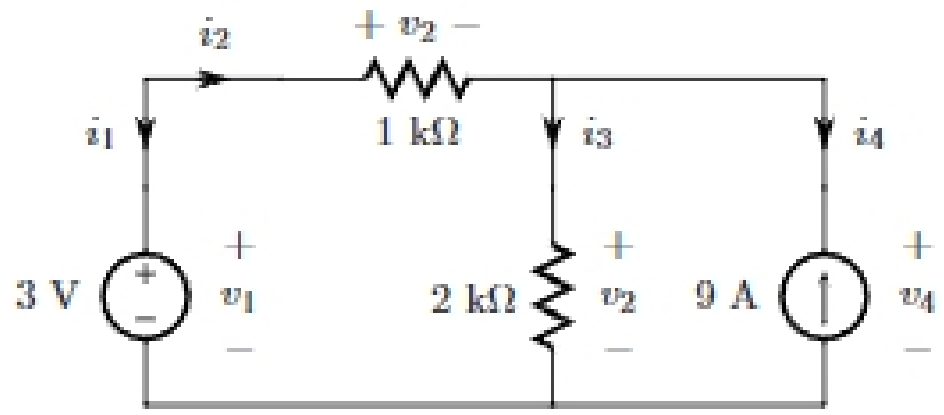
(A) How many nodes are there in the circuit? Write a KCL equation for each node in terms of the branch currents i_k. How many of the KCL equations are independent?

(B) How many loops are there in the circuit? Write a KVL equation for each loop in terms of the branch voltages v_k. How many of the KVL equations are independent?

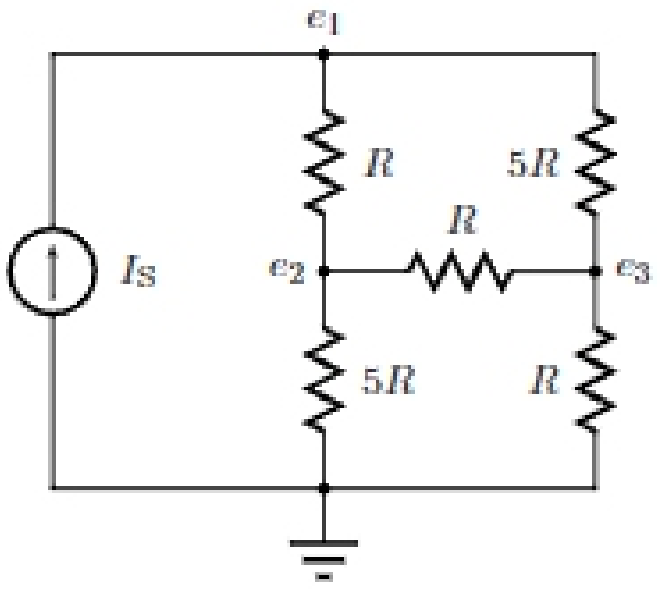
(C) Write an expression for the v-i constitutive law for each element.

(D) By combining the independent equations from Parts (A) and (B) with the equations from Part (C), you should have a set of eight linear equations, matching in number the set of i_k plus v_k. Solve the equations to find all four i_k and all four v_k. Summarize your findings in a table.

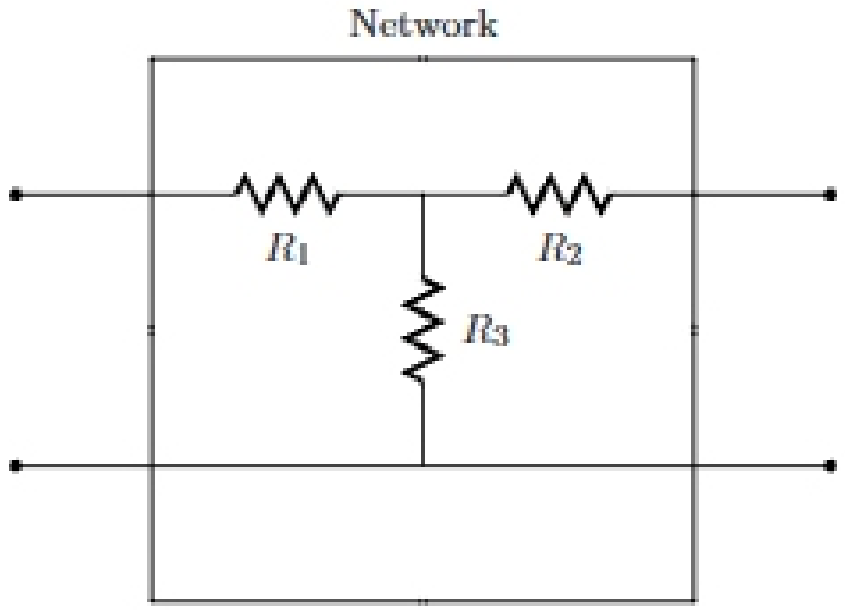
(E) Find all four branch powers $v_k i_k$. Show that the sum of the four $v_k i_k$ is zero, and hence that energy is conserved in the circuit. (If energy is not conserved, then you made a mistake.) Which branch elements source power and which branch elements sink power?



Problem 1.3: Using the node method, analyze the network below and find all node voltages, and then all branch voltages and currents. Note the definition of the reference node.



Problem 1.4: The following network has two ports and three resistors. The resistor values R_1, R_2 and R_3 are unknown.



Using the results of the following two experiments performed on the network, find the unknown values of the three resistors.