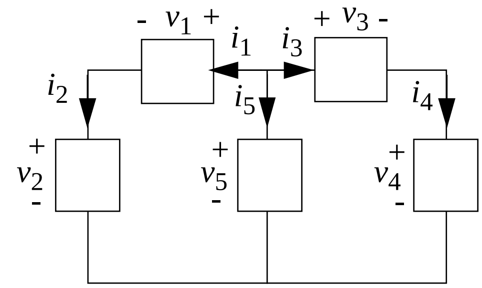
Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.002 – Electronic Circuits

Homework #1

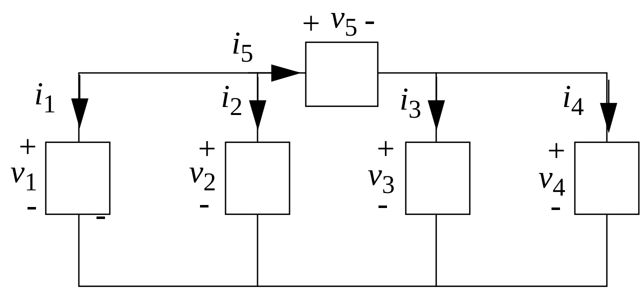
Issued 2/6/02 – Due 2/13/02

Exercise 1.1: Both networks shown below have five branches, each with defined voltages and currents. Several of the branch voltages and currents are specified. Using KVL and KCL, find the unknown branch voltages and currents.



v_1=1V v_5=5V v_4=2V

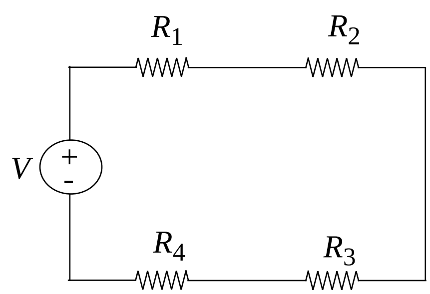
i_2=2A i_3=1A

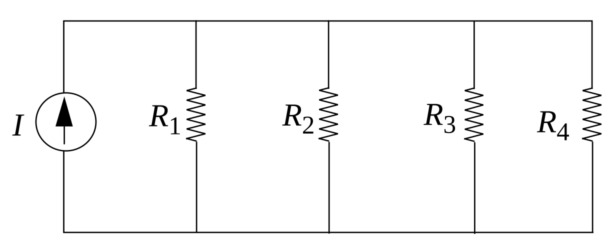


i_1=1A i_3=3A i_5=5A

v_2=2V v_3=4V

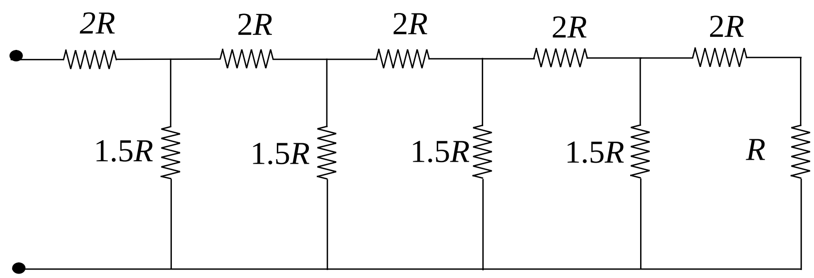
Exercise 1.2: For both networks shown below, find the voltage across, and the current through each element in the network. Be sure to make the polarity of the voltages and currents clear.

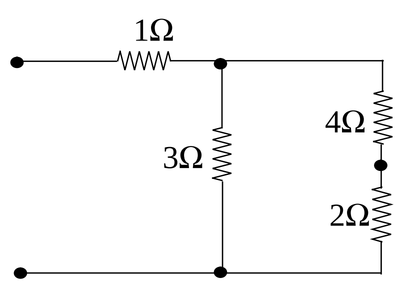


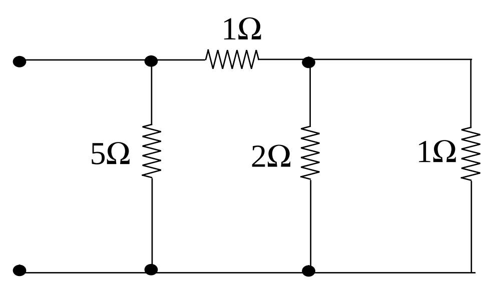


Exercise 1.3: A collection of four resistors includes two 1-Ω resistors and two 2-Ω resistors. What is the largest-valued resistor that can be synthesized using one or more resistors from the collection? What is the smallest-valued resistor that can be synthesized using one or more resistors from the collection? How can a 2.4-Ω resistor be synthesized using one or more resistors from the collection?

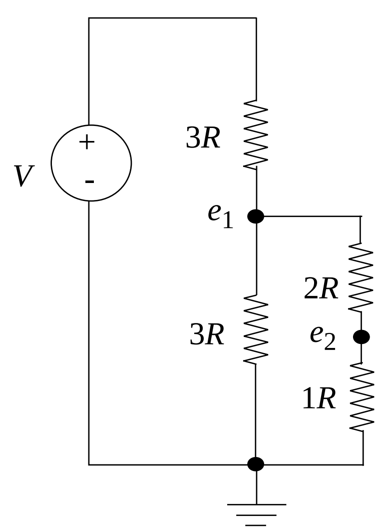
Problem 1.1: Find the equivalent resistance of the following networks as viewed from their ports.

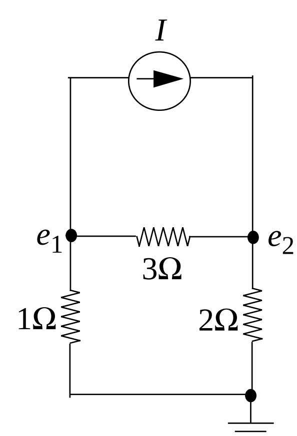




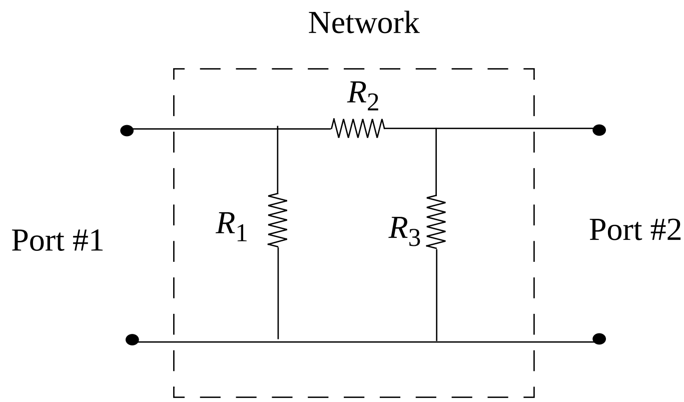


Problem 1.2: Using node analysis, find the unknown node voltages in both networks shown below. Note the definition of the ground node in both networks.

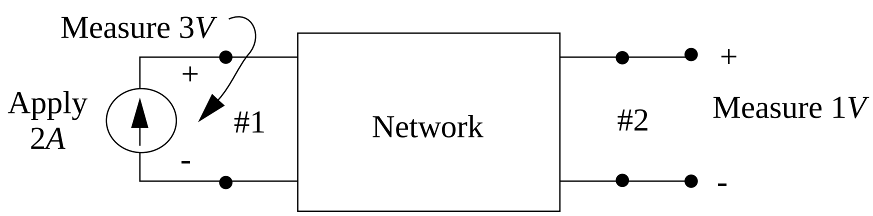


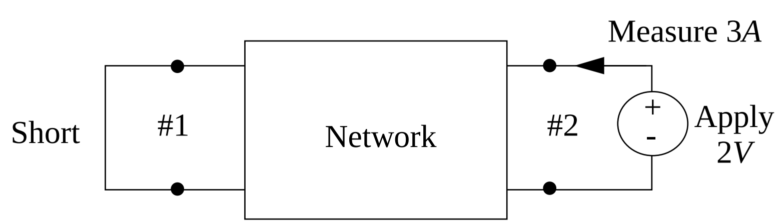


Problem 1.3: The following network has two ports and three resistors. The resistor values R_1, R_2 and R_3 are unknown.



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





Problem 1.4: Electronic circuit theory can be adapted to solve problems in other fields of engineering, as illustrated by this problem which studies the incompressible flow of a fluid through pipes. Assume that the volumetric flow rate F of an incompressible fluid through a pipe, measured in m^3/s, is proportional to the pressure drop P across the pipe from one end of the pipe to the other, measured in N/m^2. Note that positive flow is defined in the direction of decreasing pressure along the pipe. The flow resistance R for the pipe, measured in Ns/m^5, is then defined by $R = P/F$. This behavior can be modeled by a resistor if pressure is modeled by voltage, flow rate is modeled by current, and flow resistance is modeled by electrical resistance. Similarly, a pump that acts as a pressure source can be modeled electrically as a voltage source. Finally, KCL adapted for incompressible fluid flow states that the sum of the flows into a joint connecting two or more pipes is zero. Similarly, KVL adapted for incompressible fluid flow states that the sum of the pressure drops around a loop of pipes and pumps is zero. Given this analogy, find the pressures P_1 and P_2 above atmospheric pressure in the flow circuit shown below. you may find it convenient to think of atmospheric pressure as the equivalent of electrical ground. (Hint: see Problem 1.2).