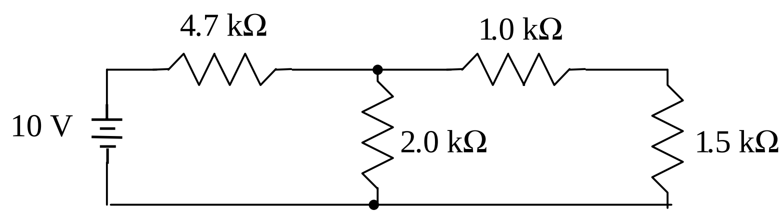
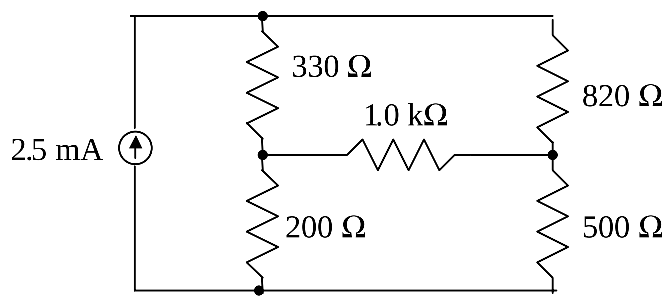
2. Problems

1. In the ladder circuit shown below



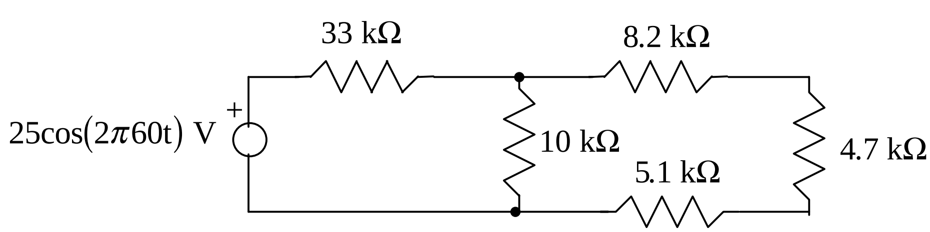
   A. Find all of the branch voltages and branch currents.
   B. Find the power absorbed by each branch. Verify that the branch powers sum to zero.

2. In the bridge circuit shown below



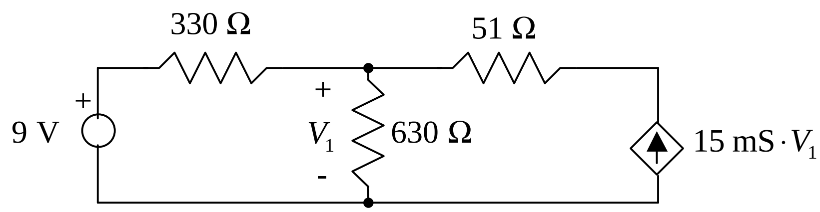
   A. Find all of the branch voltages and branch currents.
   B. Find the power absorbed by each branch. Verify that the branch powers sum to zero.

3. In the circuit shown below



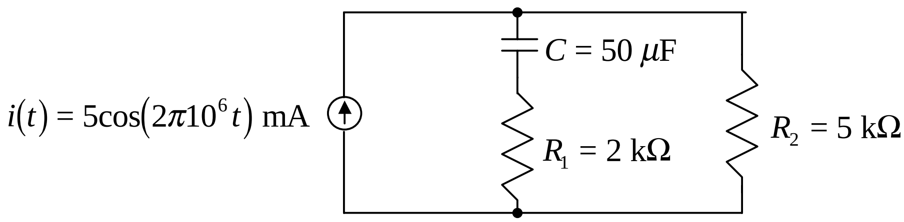
   A. Find all of the branch voltages and branch currents.
   B. Determine the direction in which current is actually flowing in the $4.7\ \text{k}\Omega$ resistor at time $t = 4.17\ \text{ms}$.
   C. Find the instantaneous power $p(t)$ delivered to the $10\ \text{k}\Omega$ resistor. When the resistor current reverses direction does the direction of power flow reverse as well? Explain.

4. The circuit shown below contains a dependent source.



A. Find all of the voltages and currents.
B. Find the power absorbed by the dependent source.
C. Is the dependent source actually a source of energy or a sink?

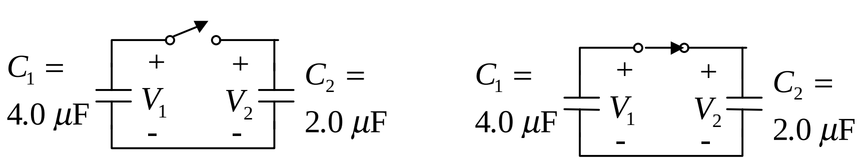
5. Consider the circuit shown below:



A. Label each branch voltage and current.
B. Write a constituent equation for each branch.
C. Write KCL equations for all but one of the nodes.
D. How many KVL equations are needed? Write KVL equations around an appropriate number of circuit loops.
E. What kind of equations are these, linear or nonlinear, algebraic or differential? (Do not solve the equations.)

6. The Two-Capacitor Problem.

A. In Fig. A below, $V_1 = 10$ V and $V_2 = 0$. Find the charge stored on (the top plate of) capacitor C_1. Repeat for capacitor C_2.
B. Find the total energy stored in the two capacitors.

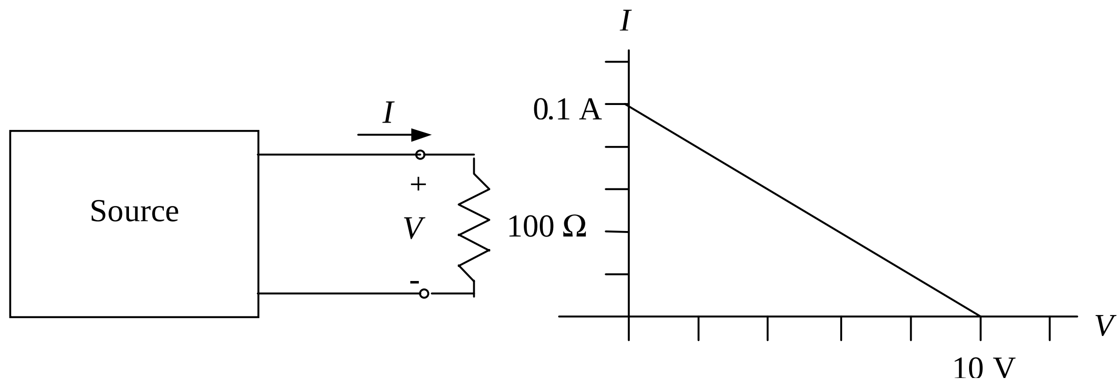


A B

C. Now suppose that the switch is closed, as in Fig. B. What does KVL tell you about the voltages V_1 and V_2?
D. Using conservation of charge, find the value of voltage V_1.
E. Find the total energy stored in the two capacitors.

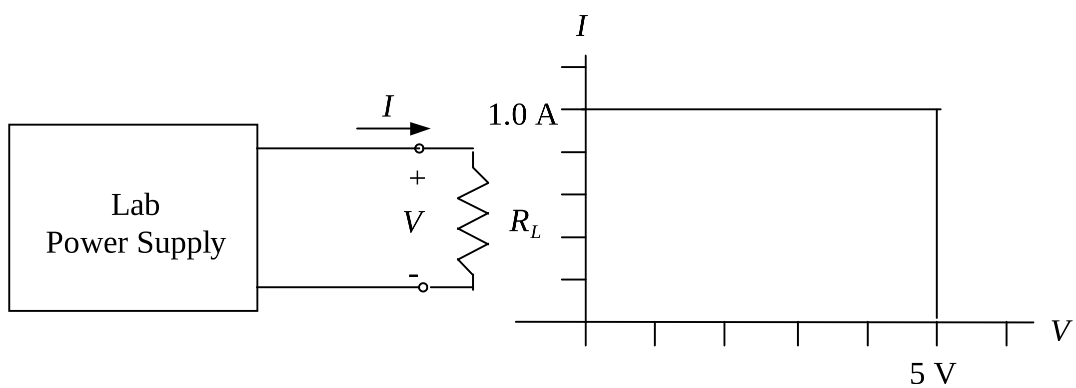
F. Still referring to Fig. B, ignore conservation of charge and use conservation of energy to find the value of voltage V_1.
G. Now find the charge stored on (the top plate of) each capacitor and the total charge.
H. What is going on here, anyway?

7. The diagram below shows a source driving a resistive load. The I-V characteristic of the source is also shown.



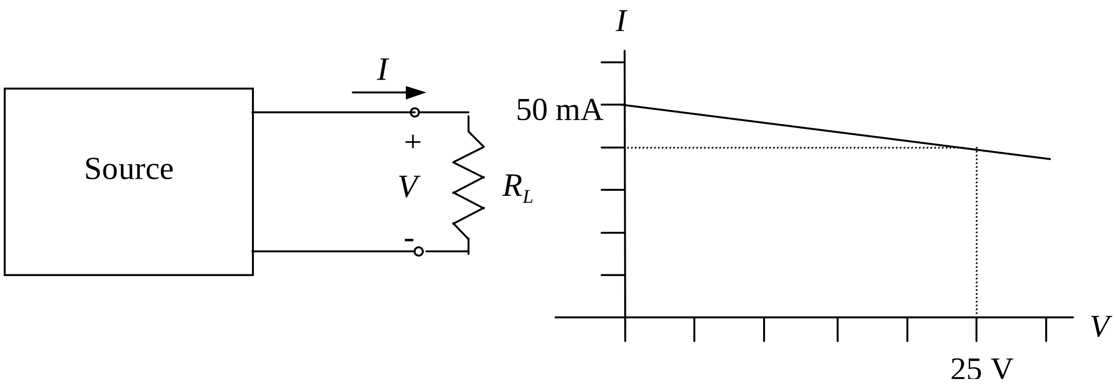
A. Plot the I-V characteristic of the load on the same axes as the I-V characteristic of the source.
B. Find the load voltage and current.

8. The diagram below shows a "five volt, one amp" laboratory power supply driving a resistive load. The I-V characteristic of the power supply is also shown.



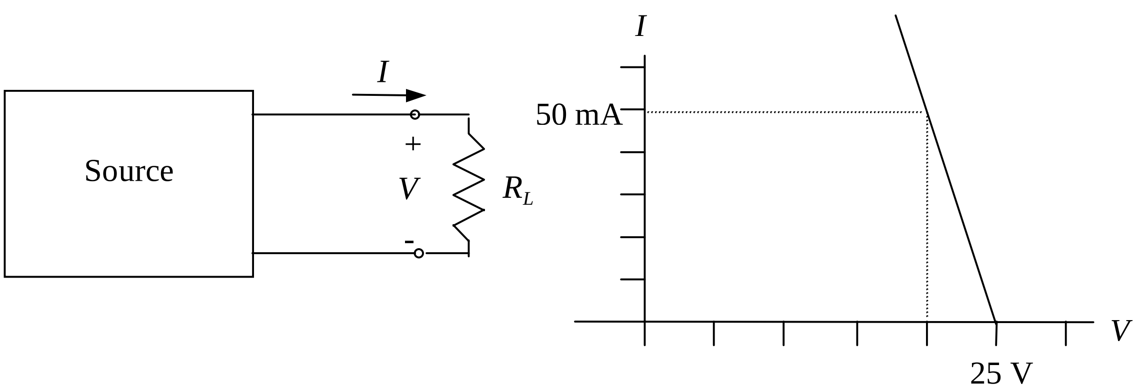
A. Suppose the load resistance is given by $R_L = 10\ \Omega$. Find the load voltage and load current.
B. Suppose the load resistance is given by $R_L = 2\ \Omega$. Find the load voltage and load current.
C. Find the smallest value of load resistance R_L for which the load voltage will be 5 V.
D. A short circuit is accidentally placed across the load resistance. Find the power supply current I.

9. The diagram below shows a source driving a resistive load. The I-V characteristic of the source is also shown.



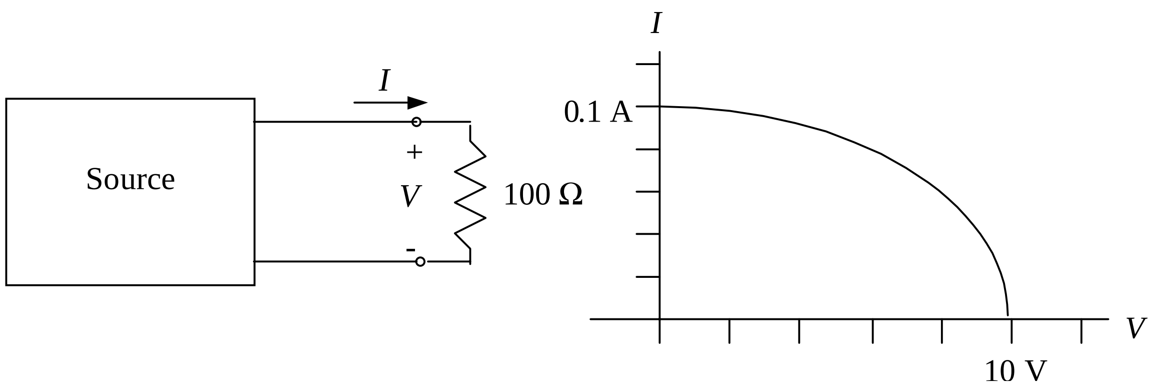
A. Find the Norton equivalent circuit model of the source.
B. Suppose the load resistance is $R_L = 200\ \Omega$. Find the load current and load voltage. You may use either the I-V characteristic or the Norton equivalent circuit.
C. By what percentage does the load current change if the load resistance increases by 10%?
D. Would the load current in Part C remain more nearly constant if the source I-V characteristic were more nearly horizontal or more steeply inclined? Does this correspond to a larger or a smaller Norton equivalent resistance?

10. The diagram below shows a source driving a resistive load. The I-V characteristic of the source is also shown.



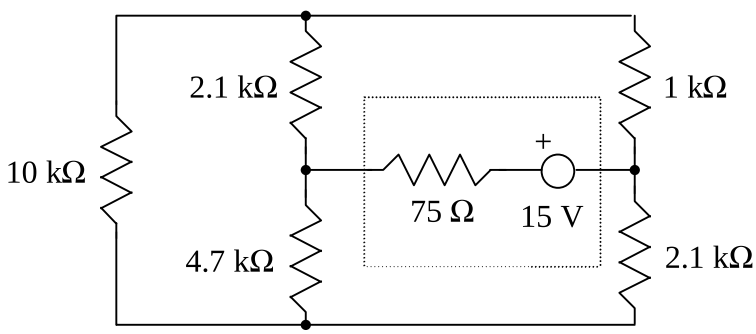
A. Find the Thevenin equivalent circuit model of the source.
B. Suppose the load resistance is $R_L = 1000\ \Omega$. Find the load voltage and load current. You may use either the I-V characteristic or the Thevenin equivalent circuit.
C. By what percentage does the load voltage change if the load resistance decreases by 10%?
D. Would the load voltage in Part C remain more nearly constant if the source I-V characteristic were more nearly vertical or less steeply inclined? Does this correspond to a larger or a smaller Thevenin equivalent resistance?

11. The diagram below shows a source driving a resistive load. The I-V characteristic of the source is also shown.

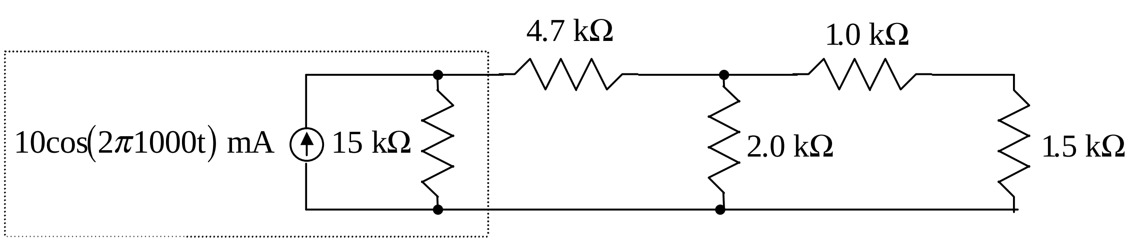


A. Plot the I-V characteristic of the load on the same axes as the I-V characteristic of the source.
B. Find the load voltage and current.
C. Can the source be represented by a Thevenin equivalent? Explain.

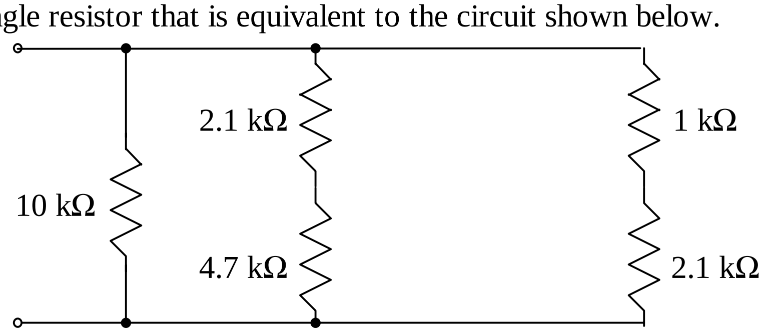
12. Replace the source in the circuit below by its Norton equivalent. Do not solve the circuit.



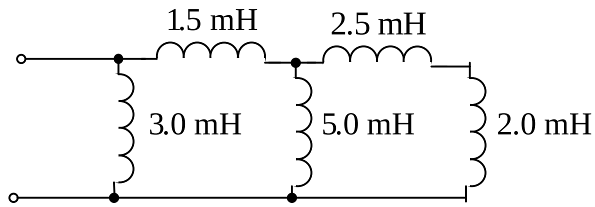
13. Replace the source in the circuit below by its Thevenin equivalent. Do not solve the circuit.



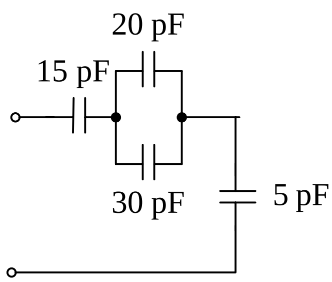
14. Find a single resistor that is equivalent to the circuit shown below.



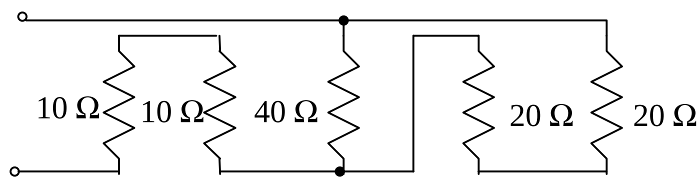
15. Find a single inductor that is equivalent to the circuit shown below.



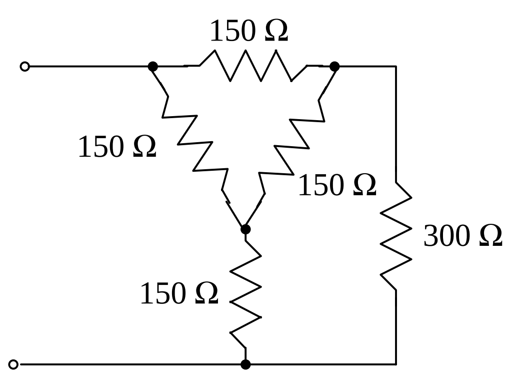
16. Find a single capacitor that is equivalent to the circuit shown below.



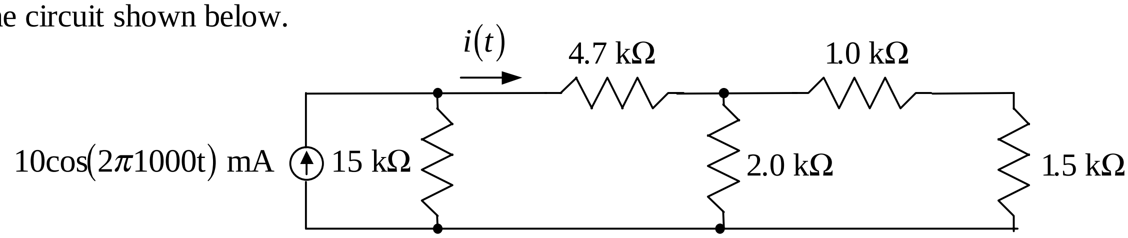
17. Find a single resistor that is equivalent to the circuit shown below.



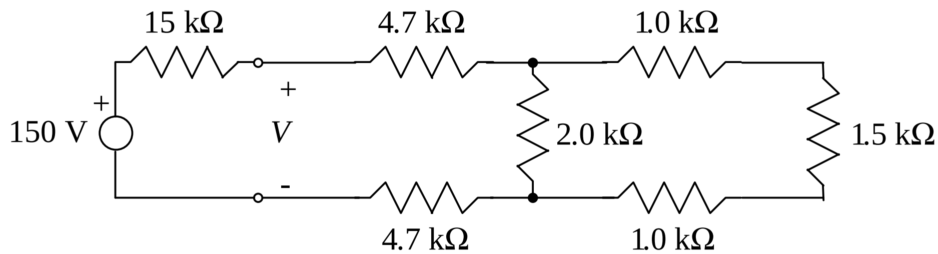
18. Find a single resistor that is equivalent to the circuit shown below.
(Hint: You cannot reduce this circuit using series and parallel combinations.)



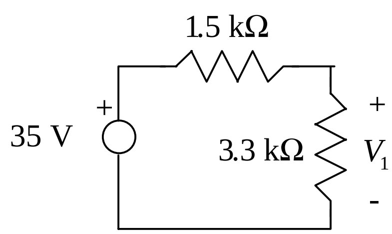
19. Use source transformations and series and parallel combinations to find the current $i(t)$ in the circuit shown below.



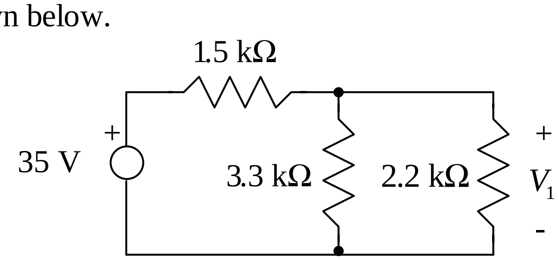
20. Use source transformations and series and parallel combinations to find V in the circuit shown below.



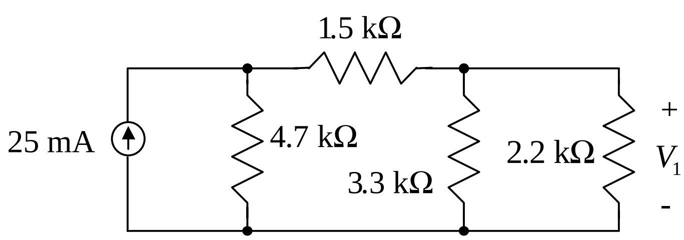
21. Use the voltage divider to find the voltage V_1 in the circuit shown below.



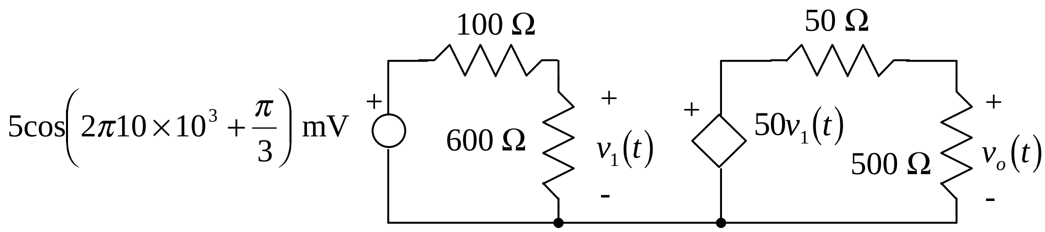
22. Use the voltage divider along with series and parallel combinations to find the voltage V_1 in the circuit shown below.



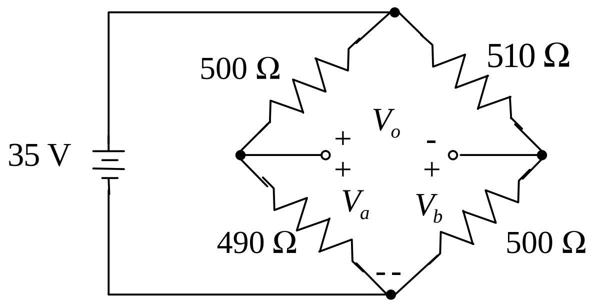
23. Use the voltage divider along with series and parallel combinations and source transformations to find the voltage V_1 in the circuit shown below.



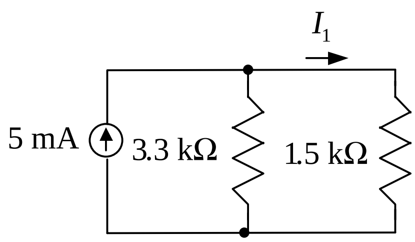
24. Use the voltage divider to find the voltage $v_o(t)$ in the circuit below.



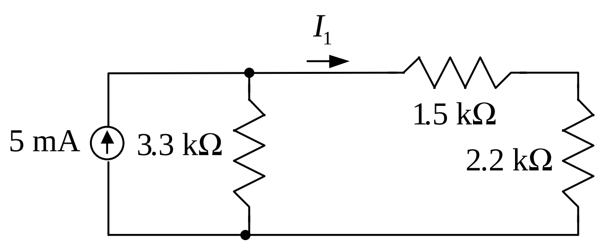
25. Use the voltage divider to find the voltages V_a and V_b in the Wheatstone bridge circuit shown below. Then find the voltage V_o.



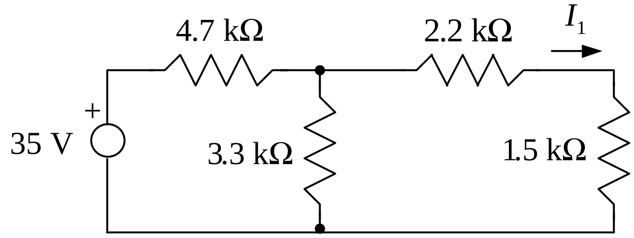
26. Use the current divider to find the current I_1 in the circuit shown below.



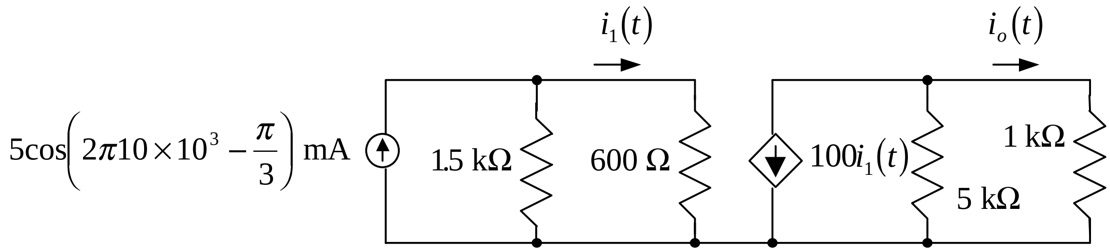
27. Use the current divider along with series and parallel combinations to find the current I_1 in the circuit shown below.



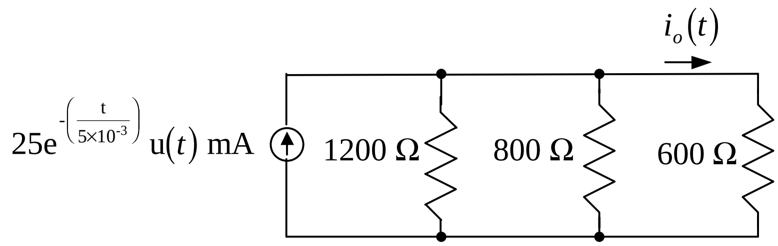
28. Use the current divider along with series and parallel combinations and source transformations to find the current I_1 in the circuit shown below.



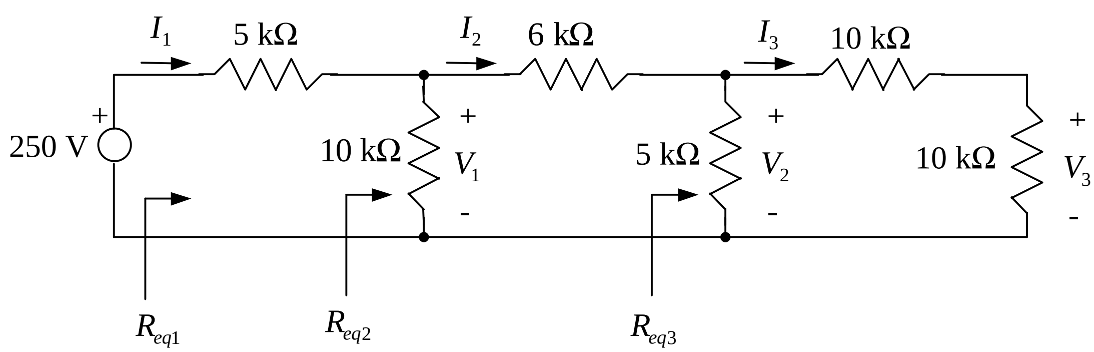
29. Use the current divider to find the current $i_o(t)$ in the circuit below.



30. Use the current divider to find the current $i_o(t)$ in the circuit below.

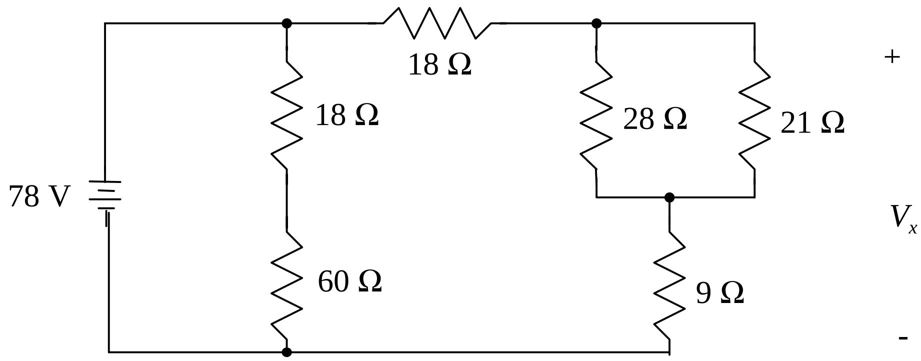


31. Consider the ladder network shown below.



A. Find successively the equivalent resistances R_{eq3}, R_{eq2}, and R_{eq1}.
B. Use the voltage divider to find successively V_1, V_2, and V_3.
C. Find the current I_1. Then use the current divider to find successively I_2 and I_3.

32. Find the value of the voltage V_x in the circuit shown below.


18 Ω
18 Ω
28 Ω
21 Ω
78 V
60 Ω
9 Ω
+
V_x
-